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Akademiya Nauk SSSR, Bulletin [Izvestiya], Geophysics Series. in English translation (American Geophysical Union). New York.
Alberta Society of Petroleum Geologists, Journal. Calgary, Alberta.
American Association of Petroleum Geologists, Bulletin. Tulsa, Oklahoma.
American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
American Petroleum Institute, Proceedings, Section 6 (Interdivisional). New York.
American Scientist. Easton, Pennsylvania.
American Water Works Association, Journal. Lancaster, Pennsylvania.
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Arizona Bureau of Mines, [Map]; Mineral Technology Series, Bulletin. Tucson, Arizona.
Arizona, University, Bulletin; Physical Science Bulletin. Tucson, Arizona.
Asbestos. Philadelphia
Asociación Mexicana de Geólogos Petroleros, Boletín. México, D. F.
California, Division of Mines, Mineral Information Service. San Francisco.
Canada, Geological Survey, Bulletin; Map; Memoir. Ottawa.
Canadian Field-Naturalist. Ottawa.
Canadian Institute of Mining and Metallurgy, Transactions. Montreal.
Canadian Journal of Botany (National Research Council of Canada). Ottawa.
Canadian Journal of Physics (National Research Council of Canada). Ottawa.
Canadian Mining and Metallurgical Bulletin. Montreal.
Colorado School of Mines, Quarterly. Golden, Colorado.
Columbia University, Lamont Geological Observatory, Contribution. Palisades, New York.
Economic Geology (Society of Economic Geologists). Lancaster, Pennsylvania.
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Hawaii, Agricultural Experiment Station, Technical Paper. Honolulu.
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Journal of Geophysical Research. Washington, D. C.
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Journal of Sedimentary Petrology. Tulsa, Oklahoma.
Kansas Agricultural Experiment Station, Contribution. Manhattan, Kansas.
Kansas, State Geological Survey, Bulletin. Lawrence, Kansas.
Kansas, University, Dept. of Entomology, Contribution. Lawrence, Kansas.
Michigan, University, Dept. of Mineralogy, Contribution. Ann Arbor, Michigan.
Montana Bureau of Mines and Geology, Bulletin; Special Publication. Butte, Montana.
New Hampshire State Planning and Development Commission, Mineral Resources Survey. Concord, New Hampshire.
Ohio, Division of Geological Survey, Information Circular. Columbus, Ohio.
Ohio Journal of Science. Columbus, Ohio.
Pacific Science. Honolulu, Hawaii.
Pennsylvania Academy of Science, Proceedings. [Pittsburgh, Pennsylvania].
Pennsylvania Geological Survey, Bulletin. Harrisburg, Pennsylvania.
Pennsylvania State University, College of Mineral Industries, Contribution. University Park, Pennsylvania.
Quebec (Province), Dept. of Mines, Geological Report; Preliminary Report. Quebec.
Research Council of Alberta, Contribution Series; Geological Division, Preliminary Report. Edmonton, Alberta.
Rutgers University, Engineering Research Bulletin. New Brunswick, New Jersey.
Science. Washington, D. C.
Shale Shaker (Oklahoma City Geological Society). Oklahoma City, Oklahoma.
Soil Science Society of America, Proceedings. Danville, Illinois.
Tennessee, Dept. of Conservation, Division of Geology, Bulletin; Report of Investigations. Nashville, Tennessee.
Texas, University, Bureau of Economic Geology, Report of Investigations. Austin, Texas.
U. S. Geological Survey, Bulletin; Geophysical Investigations Map; Ground Water Notes; Mineral Investigations Map; Miscellaneous Investigations Map; Professional Paper; Water-Supply Paper. Washington, D. C.
U. S. Snow, Ice and Permafrost Research Establishment, Research Report. Wilmette, Illinois.
Washington University, St. Louis, Missouri, Dept. of Geology, Publication.
Western Ontario, University, Dept. of Geology, Contribution. London, Ontario.

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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

1-2663. Cass, J.T. RECONNAISSANCE GEOLOGIC MAP OF THE CANDLE QUADRANGLE, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-287, scale 1: 250,000, contour intervals 200 and 1,000 ft., lat. 65°-66°N., long. 159°-162°W., 1959.

1-2664. Cass, J.T. RECONNAISSANCE GEOLOGIC MAP OF THE MELOZITNA QUADRANGLE, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-290, scale 1: 250,000, contour intervals 200 and 1,000 ft., lat. 65°-66°N., long. 153°-156°W., 1959.

1-2665. Cass, J.T. RECONNAISSANCE GEOLOGIC MAP OF THE NORTON BAY QUADRANGLE, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-286, scale 1:250,000, contour intervals 200 and 1,000 ft., lat. 64°-65°N., long. 159°-162°W., 1959.

1-2666. Cass, J.T. RECONNAISSANCE GEOLOGIC MAP OF THE NULATO QUADRANGLE, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-291, scale 1:250,000, contour intervals 200 and 1,000 ft., lat. 64°-65°N., long. 156°-159°W., 1959.

1-2667. Cass, J.T. RECONNAISSANCE GEOLOGIC MAP OF THE RUBY QUADRANGLE, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-289, scale 1:250,000, contour intervals 200 and 1,000 ft., lat. 64°-65°N., long. 153°-156°W., 1959.

1-2668. Williams, John R. GEOLOGY OF THE WESTERN PART OF THE BIG DELTA (D-6) QUADRANGLE, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-297, scale 1:63,360, lat. 64°45'-65°N., long. 146°30'-147°W., 1959.

This report covers about 65 sq. mi. of the Chena and Little Chena valleys and adjacent Yukon-Tanana upland E. of Fairbanks. Precambrian schist is extensively mantled by loess on hilltops, by undifferentiated silt in creek valleys, and by floodplain and terrace alluvium in Chena and Little Chena valleys. The text includes a section on foundation problems related to permafrost and seasonal frost and tabulation of engineering characteristics of map units. --U. S. Geol. Survey.

1-2669. Arizona Bureau of Mines. GEOLOGIC MAP OF COCHISE COUNTY, ARIZONA: Univ. Arizona, scale 1:375,000, 1959.

1-2670. Petersen, Richard G., and David A. Phoenix. PRELIMINARY GEOLOGIC MAP OF THE PARIA PLATEAU NE QUADRANGLE, COCONINO COUNTY, ARIZONA: U.S. Geol. Survey, Mineral Inv. Map MF-214, scale 1:24,000, contour interval 40 ft., lat. 36°52'30"-37°N., long. 111°45'-111°52'30"W., 1959.

1-2671. Dibblee, Thomas W., Jr. GEOLOGIC MAP OF THE ALPINE BUTTE QUADRANGLE, CALIFORNIA: U.S. Geol. Survey, Mineral Inv. Map MF-222, scale 1:62,500, contour interval 40 ft., lat. 34°30'-34°45'N., long. 117°45'-118°W., 1959.

1-2672. Dibblee, Thomas W., Jr. PRELIMINARY GEOLOGIC MAP OF THE MOHAVE QUADRANGLE, CALIFORNIA: U.S. Geol. Survey, Mineral Inv. Map MF-219, scale 1:62,500, contour interval 100 ft., lat. 35°-35°15'N., long. 118°-118°15'W., 1959.

1-2673. Bush, Alfred L., Owen T. Marsh, and Richard B. Taylor. PRELIMINARY GEOLOGIC MAP OF THE LITTLE CONE QUADRANGLE, SAN MIQUEL COUNTY, COLORADO: U.S. Geol. Survey, Mineral Inv. Map MF-223, scale 1:24,000, contour interval 40 ft., lat. 37°52'30"-38°N., long. 108°-108°07'30"W., 1959.

1-2674. McGill, George E. GEOLOGIC MAP OF THE NORTHWEST FLANK OF THE FLINT CREEK RANGE, WESTERN MONTANA: Montana Bur. Mines & Geology, Spec. Pub. 18, (Geol. Inv. Map 3), scale 1:31,680, text, 1959, 27 refs.

The NW. flank of the Flint Creek range is a mountainous area of about 100 sq. mi. immediately NE. of Philipsburg, Montana.

The exposed stratigraphic section is about 16,000 ft. thick and includes at least 6,500 ft. of Precambrian Beltian impure carbonates, argillites, and quartzites; 6,000 ft. of Paleozoic carbonates with subordinate clastics; and at least 3,300 ft. of Mesozoic clastics with subordinate carbonates. The Philipsburg and Royal granitic batholiths, marginal to the area, have contact metamorphosed the sedimentary rocks in an aureole 1.5 mi. wide reaching amphibolite and pyroxenite facies in a narrow and discontinuous inner zone.

Most of the structures trend N. -S. and plunge northward. The dominant structure is the folded Philipsburg overthrust that has moved Precambrian and Paleozoic rocks eastward at least 5 mi. W. of the overthrust are mostly broad folds with W. -dipping axial planes, but E. of the overthrust are nearly isoclinal overturned folds with E. -dipping axial planes. Several major steep reverse faults offset the folds and the overthrust.

The Laramide deformational sequence is as follows: 1) folding; 2) thrusting with concommitant drag folding of upper plate and folding of incompetent younger rocks E. of the upper plate; 3) reverse faulting and minor folding; 4) emplacement of granitic plutons with cross-folding of adjacent earlier structures (cross-folding plus lack of shearing in the granites suggest emplacement as magma).

Although a minor mining area in the past, economic possibilities seem limited to commercially marginal deposits of limestone, dolomite, and phosphate. --Auth.

1-2675. Balsley, James R., and others. AEROMAGNETIC AND GEOLOGIC MAP OF THE LOON LAKE QUADRANGLE AND PART OF THE CHATEAUGAY QUADRANGLE, FRANKLIN COUNTY, NEW YORK: U.S. Geol. Survey, Geophys. Inv. Map GP-191, scale 1:62,500, contour intervals 100 to 500 gammas, lat. 44°30'-44°52'30"N., long. 74°-74°15'W., 1959.

1-2676. Balsley, James R., and others. AEROMAGNETIC AND GEOLOGIC MAP OF THE OSWEGATCHIE QUADRANGLE, ST. LAWRENCE, HER-

KIMER, AND LEWIS COUNTIES, NEW YORK: U.S. Geol. Survey, Geophys. Inv. Map GP-192, scale 1:62,500, contour intervals 100 and 500 gammas, lat. 44°-44°15'N., long. 75°-75°15' W., 1959.

1-2677. Balsley, James R., and others. AERO-MAGNETIC AND GEOLOGIC MAP OF THE SANTA CLARA QUADRANGLE AND PART OF THE ST. REGIS QUADRANGLE, FRANKLIN COUNTY, NEW YORK: U.S. Geol. Survey, Geophys. Inv. Map GP-190, scale 1:62,500, contour intervals 100 and 500 gammas, lat. 44°25'-44°45'N., long. 74°15'-74° 30'W., 1959.

1-2678. Balsley, James R., and others. AERO-MAGNETIC AND GEOLOGIC MAP OF THE TUPPER LAKE QUADRANGLE, ST. LAWRENCE, HAMILTON, AND FRANKLIN COUNTIES, NEW YORK: U.S. Geol. Survey, Geophys. Inv. Map GP-193, scale 1:62,500, contour intervals 100 and 500 gammas, lat. 44°-44° 15'N., long. 74°30'-74°45'W., 1959.

1-2679. Smith, Ollie, Jr. ISOPACH MAP OF THE WELLS CREEK DOLOMITE IN MIDDLE TENNESSEE: scale 1:625,000, text on map sheet, Nashville, Tennessee, Dept. of Conservation & Commerce, Division of Water Resources, 1959, 7 refs.

The map of an important subsurface "marker" bed above a principal water-bearing formation in middle Tennessee was prepared as part of a project in cooperation between the U. S. Geological Survey and the Tennessee Division of Water Resources. A 1,500 word text accompanies the map.

Traced on the map is the thickness of the easily recognized Wells Creek dolomite [Lower Ordovician] which immediately overlies the Knox dolomite, the principal aquifer. The Wells Creek is known to crop out in only 2 localities in the area of study, and is generally 400 to 1,500 ft. below the land surface.

The map covers an area of about 18,000 sq. mi. between the Cumberland Plateau and the Tennessee River. Drill cuttings and cores from 120 wells were examined in the laboratory. Electric logs also were used, to supplement the sample studies. --Auth.

1-2680. Bramkamp, R.A., and Leon F. Ramirez. GEOGRAPHIC MAP OF THE CENTRAL PERSIAN GULF QUADRANGLE, KINGDOM OF SAUDI ARABIA: U.S. Geol. Survey, Misc. Inv. Map I-209 B, scale 1:500,000, lat. 24°-28°N., long. 51°-54°E., 1959.

1-2681. Bramkamp, R.A., and Leon F. Ramirez. GEOGRAPHIC MAP OF THE NORTHEASTERN RUB AL KHALI QUADRANGLE, KINGDOM OF SAUDI ARABIA: U.S. Geol. Survey, Misc. Inv. Map I-214 B, scale 1:500,000, lat. 20°-24°N., long. 51°-54°E., 1959.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Stratigraphy 1-2745; Geohydrology 1-2886.

1-2682. Sikabonyi, L.A., and W.J. Rodgers. PALEOZOIC TECTONICS AND SEDIMENTATION IN THE NORTHERN HALF OF THE WEST CANADIAN BASIN: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 9, 15 maps, chart, 6 secs., diag., Sept. 1959, 17 refs.

The area comprising northern Alberta, northeastern British Columbia and the southern portion of the Northwest Territories [56°-62°N. 117°-125°W.] is a geological province which was occupied during most of Paleozoic time by a narrow basin and 3 positive faulted blocks - the Peace River uplift, the Fort Nelson uplift and the Tathlina Lake uplift.

The faults defining the tectonic units of this area originated during the Siluro-Ordovician "Taconian" disturbance. The block movements along these early Paleozoic faults were continuously renewed during the Paleozoic and culminated in an extensive period of faulting during post-Mississippian time.

The main tectonic feature of the area is the north Alberta ridge which was positive during the pre-Middle Devonian but negative during the rest of the Paleozoic. Its axis trends NW.-SE. The principal faults of the area have a NE.-SW. trend. The main facies changes and reef growth show a close relationship to the regional tectonic features and to the faulting.

The basin sank during Elk Point and Upper Devonian times and was elevated during Mississippian time. The thickening of the Mississippian and Pennsylvanian sediments above the Peace River arch is a result of preservation rather than deposition.

Downwarping of the western edge of the Paleozoic basin formed the E. flank of the Mesozoic basin. --Auth. concl.

1-2683. Duffell, Stanley. WHITESAIL LAKE MAP-AREA, BRITISH COLUMBIA: Canada, Geol. Survey, Mem. 299, 119 p., 8 illus., 6 maps (2 in pocket incl. Map 1064 A, scale 1:253,440), 2 profiles, table, 1959, 70 refs.

This map-area in W.-central British Columbia covers approximately 80 mi. along the eastern contact of the Coast Range batholith. It includes a large part of the storage basin and power installations for the generation of electrical power required for the aluminum smelter at Kitimat.

Volcanic and sedimentary strata, deposited under eugeosynclinal conditions throughout the Mesozoic era, underlie the eastern and northeastern parts of the area. Triassic, Jurassic, and Lower Cretaceous strata were identified by fossil evidence. A review and reevaluation of the Takla and Hazelton groups is made on the basis of their relationships in the area.

Granodioritic and dioritic rocks of the coast intrusions invade the eugeosyncline strata and are dominant in the western and southwestern parts of the area. Contacts of cupolas, stocks, and small batholiths E. of the main mass are commonly intrusive; contacts of the main mass may be sharply intrusive, referable to granitization, or faults. Deposits of Au, Ag, Pb, Zn, and Cu have been found in the Mesozoic rocks.

Upper Cretaceous to Oligocene, disturbed, acid to intermediate volcanic flow and fragmental rocks overlie the Hazelton and Takla groups and bodies of the coast intrusions. These are in turn overlain by undisturbed Oligocene or later basaltic flows.

The whole area has been glaciated, the latest direction of ice movement being approximately N. 80E. as indicated by glacial striae and drumlinoid terrain. Depth of ice was at least 4,500 ft. --Auth.

1-2684. Knowles, David M., and R. Gordon Gastil. METAMORPHOSED IRON FORMATION IN SOUTHWESTERN LABRADOR: Can. Mining & Metall. Bull., v. 52, no. 568, p. 503-510, 2 illus., 2 maps, secs., diag., Aug. 1959, 19 refs.; also pub. as:

Can. Inst. Mining & Metallurgy, Trans., v. 62, p. 265-272, 1959.

The Precambrian sedimentary series of the Labrador geosyncline, including iron formation, extends into southwestern Labrador and adjacent Quebec. The iron formation consisted of primary oxide, silicate, and carbonate facies which were deposited simultaneously in an irregular basin in response to migratory environmental conditions. The iron formation isochemically recrystallized to coarse-grained quartz-iron oxide, iron silicate, and quartz-iron carbonate rocks during prolonged regional metamorphism.

The rocks are deformed on 2 deformation axes intersecting at large angles and are characterized by isoclinal to recumbent folds. Parts of the formation have been profoundly affected by a post-metamorphic leaching and oxidizing environment. --Auth.

1-2685. Friends of Pleistocene Geology, Eastern Section. 22ND REUNION, MAY 16 AND 17, 1959, LONDON, ONTARIO: 2d ed., Western Ontario, Univ., Dept. Geology, Contr. no. 25, 30 p., 10 figs. incl. maps, secs., 1959, 7 refs.

In 2 sections:

Dreimanis, Aleksis, and R. W. Packer. Field Trip Guide, p. 1-23.

Road logs are presented for 2 field trips, one in the vicinity of London, Ontario, the other a round trip from London to the N. shore of Lake Erie. Pleistocene geology is discussed at each stop.

Dreimanis, Aleksis. Proposed Local Stratigraphy of the Wisconsin Glacial Stage in the Area South of London, Southwestern Ontario, p. 24-30.

Results of studies by the writer, G. H. Reavely, and students of the Geology Department of the University of Western Ontario since 1949. "Those Pleistocene deposits of SW. Ontario, which are exposed in river banks and lake shore cliffs, or artificial excavations, appear to belong to the last ice age, as no interglacial deposits or paleosols, which may indicate climatic conditions similar to those of the present time, have been found. Interstadial cool climate deposits, older than 40,000 radiocarbon years, suggest that the last ice age extended farther back in time than the classical Wisconsin. Therefore the writer prefers to apply the name of Wisconsin, which means the last ice age in the Great Lakes region, to the entire complex of glacial and interstadial times between the last true interglacial age... and the Recent. In this meaning the Wisconsin is subdivided here into early Wisconsin (mostly glacial), mid-Wisconsin (mostly interstadial), and main Wisconsin (corresponding to the classical Wisconsin of the midwestern region of the Great Lakes)." The Wisconsin history in this area is traced. --A. C. Sangree.

1-2686. Bergeron, Robert. PRELIMINARY REPORT ON POVUNGNITUK RANGE AREA, NEW QUEBEC: Quebec, Dept. Mines, Prelim. Rept. no. 392, 9 p., fold. geol. map (Prelim. Map no. 1279), scale 1:126,720, 1959, 3 refs.

This 3,235-sq. mi. area (61°10'-62°N. 74°20'-76°W.) occupies the central part of the Cape Smith-Wakeham Bay belt about 50 mi. S. of Hudson Strait. Outcrops cover about 30% of the land surface in the southern half of the area, but only about 10% in the northern half. Glaciers traversed the area from S. to N. at the close of the Pleistocene. Eskers and ground moraines are abundant. All consolidated rocks are Precambrian. The oldest (Archean) are granodioritic gneisses and granodiorites which outcrop near the southern limit of the map-area. To the N. are 3 lithologically different E.-W.-trending zones. The Povungnituk group of sedimentary and volcanic rocks lies unconformably on the Archean. These rocks were invaded by gabbroic and ultrabasic sills and have been deformed and metamorphosed. The second zone is represented by the Chukotat group that lies unconformably on the Povungnituk. This group begins with a conglomerate or breccia, above which is 6,000-7,000 ft. of pillowed lavas with a few ultrabasic and basic sills. This group is less deformed and metamorphosed than the Povungnituk. A large thrust fault, extending from Hudson Bay to at least 50 mi. E. of the map-area, terminates the Chukotat group to the N. Rocks to the N. of the fault, considered to belong to the Povungnituk group, are believed to have been thrust over rocks of the Chukotat group. They form the third of the E.-W.-trending zones and include sedimentary, volcanic, and intrusive rocks which are very schistose and much metamorphosed. To the N. this assemblage grades into gneissic rocks. Formations N. of the fault were cut by small bodies of granite, diorite, or syenite.

Two mining companies carried out exploration work on areas of Ni-Cu mineralization during summer 1958. The writer found good quality asbestos fibers in some places in the ultrabasic rocks. --A. C. Sangree.

1-2687. Holmes, Stanley W. FANCAMP-HAUY AREA, ABITIBI-EAST ELECTORAL DISTRICT: Quebec, Dept. Mines, Geol. Rept. 84, 33 p., 16 illus. on 8 pls., 3 maps (1 in pocket), scale 1:63,360, 1959, 7 refs.

The Fancamp-Hauy area, about 5 mi. SW. of Chibougamau Lake (49°30'-49°45'N. 74°30'-74°45' W.), covers about 195 sq. mi. It was mapped in summer 1951. All consolidated rocks are Precambrian. "Much of the area is underlain by altered volcanic rocks of Keewatin type. These are associated with, and presumably overlain unconformably by, a sedimentary series varying in type from slate to boulder conglomerate. Both series are in steep isoclinal folds, are cut by faults, and are intruded by igneous rocks of basic to intermediate composition. All the foregoing rocks are intruded by granitic and dioritic types, and these in turn are cut by dikes of olivine diabase. One of the most striking features in the area is the degree of alteration, which has destroyed most of the original minerals and formed a varied group of secondary minerals."

The rocks have been subjected to complex folding and faulting. Folds are the most evident structural features, The regional trend of all rocks is to the E. or NE. Shear zones extend throughout and some may represent major faults. Quartz veins are common along most of these zones.

Ni-Cu and Au deposits are of particular economic interest and apparently represent 2 different kinds of mineralization. The Ni-Cu deposits occur as sulfide replacements; the Au occurs as fissure and fracture fillings along with tourmaline, quartz, and ankerite. Each of these deposits is described. Exploratory work 1951-1959 is described briefly in an appendix by J. E. Gilbert. --A. C. Sangree.

1-2688. Lyall, H. B. BRONGNIART-LESCURE AREA, ELECTORAL DISTRICT OF ABITIBI-EAST: Quebec, Dept. Mines, Geol. Rept. 85, 29 p., 6 illus. on 3 pls., geol. map (in pocket), scale 1:63,360, 1959, 12 refs.

The 200-sq. mi. area about 20 mi. SW. of Chibougamau Lake (74°45'-75°N. 49°30'-49°45'W.) was mapped in 1952. All consolidated rocks are Precambrian. "Approximately one-fifth of the area is occupied by Keewatinlike lavas and pyroclastics with associated minor basic intrusives. Several small basic intrusive bodies are scattered throughout the area. Most of the E. central portion is underlain by a group of schists and gneisses, a band of which protrudes westward into a large body of albite-oligoclase granite [post-Keewatin?] that occupies about four-fifths of the western half of the area. This granite forms the marginal portion of a much larger body that extends westward beyond the area for several miles. A number of diabasic dikes [Keweenawan?] intrude the granite, and 2 intrude the Keewatin volcanics." Glacial deposits conceal the bedrock in many areas, especially the NW. The Keewatin volcanic rocks have been intensely deformed. The broader structural features trend easterly. Structure of the schist-gneiss complex differs from that of the adjacent Keewatin-type rocks and is undoubtedly related to the intrusive action of the large granite body in the W. Schistosity and shearing are described. There is no evidence of major faults within the area, and jointing is not a prominent characteristic of the rocks.

The area is favorable for such minerals as Au, Ag, Cu, and Ni, and possibly Pb and Zn. An appendix to this report, by J. E. Gilbert, briefly describes surveys and diamond drilling carried out on various mining company properties to 1957. A massive sulfide body was discovered in Lévy township. Sulfides were mainly pyrite and pyrrhotite, with a little chalcopyrite, and minor amounts of sphalerite, Au, and Ag. --A. C. Sangree.

1-2689. Lyall, H. B. PRELIMINARY REPORT ON McLACHLIN-BOOTH AREA, TEMISCAMINGUE ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 391, 13 p., fold. geol. map (Prelim. Map 1278), scale 1:63,360, 1959, 2 refs.

The 307-sq. mi. area (46°45'-47°N. 78°30'-78°52'30"W.), examined in summer 1958, lies about 25 air miles from the town of Temiscaming. Consolidated rocks are all Precambrian. "The oldest are basic and feldspathic paragneisses, quartzites, and related sericitic paragneisses and schists, with minor amounts of diopside-tremolite rock. Granitic gneisses are widespread and are in part intrusive into the paragneisses and in part derived from the paragneisses. Within the paragneisses and granitic gneisses are numerous lenticular masses, and one irregular mass of metagabbro. The lenses are concordant with the gneissic structure and may represent sills. Syenite, apparently older than the granitic gneisses, occurs in 2 localities. Pink gneissic granite and pink pegmatite are the youngest acidic intrusives in the area and occur as lenticular to moon-shaped concordant masses. The youngest rocks are diabase dikes. All these rocks, with the exception of the diabase dikes, have been intensely folded at least once; in some cases 2 periods of folding can be recognized. The second period of folding appears to have been associated with faulting." Joints are relatively abundant; faults appear to be rare.

In Oct. 1957, U was discovered in micaceous quartzites in the NW. part of the area. The U minerals occur in a band of sericitic quartzite striking NE. and varying from 150 ft. wide in the SW. to 600 ft. wide in the NE. Mineralization may have been sedimentary or hydrothermal. Pyrite was found in several exposures, and graphite is common. Mining properties are described. --A. C. Sangree.

1-2690. Remick, Jerome H. PRELIMINARY REPORT ON MARGRY-PREVERT AREA, ABITIBI-EAST ELECTORAL DISTRICT: Quebec, Dept. Mine Prelim. Rept. no. 394, 17 p., fold. geol. map (Pr lim. Map 1281), scale 1:63,360, 1959, 17 refs.

This 360-sq. mi. area (49°09'-49°30'N. 75°45'-76°06'W.) was mapped in summer 1958. It lies abo 80 mi. WSW. of Chibougamau. Unstratified glacial sediments and small swamps cover much of the are Consolidated rocks are Precambrian; about four-fif of them are granitic. "A belt of hornblende schist and altered basic to intermediate volcanic rocks, w included sills of gabbro and diorite, strikes roughly E. across the northern quarter of the area and con tinues eastward and westward into the adjoining ma areas. A small band of gabbro and hornblende schi underlies a small area W. of Nicobi Lake. Discon tinuous northeasterly striking dikes of diabase and gabbro cut diagonally across the other formations." Pillow structures, schistosity, flow structure in the granite, joints, and shear zones are briefly descril Au, Ag, Cu, Zn, and Ni have been found in the map area. Several mining properties are described. -- A. C. Sangree.

1-2691. Keller, A. Samuel, and Hillard N. Reiser GEOLOGY OF THE MOUNT KATMAI AREA, ALAS U.S. Geol. Survey, Bull. 1058-G, p. 261-298, 2 illus., 2 maps (1 in pocket, scale 1:250,000, contou interval 200 ft.), 2 charts, generalized sec. (in poc et), 1959, 33 refs.

The Mount Katmai area is on the Alaska Peninsu and comprises the Mount Katmai quadrangle, the Cape Douglas area of the adjoining Afognak quadrangle, and parts of the Karluk and Naknek quadrangles. The area, which includes nearly all the Katmai National Monument, is one of high relief an is drained by streams of preglacial origin. At leas 2 ice advances are indicated by the moraine configuration. Present-day glaciation is restricted to nu erous alpine glaciers in the mountain areas. Fiftee recently active volcanoes roughly form a line from Mount Douglas to Martin Mountain.

Sedimentary rocks older than Middle Jurassic ag and of Late Jurassic, Late Cretaceous, and Eocene age are represented. Silicic and mafic igneous roc of Early and (or) Middle Jurassic and Tertiary age locally intrude the sedimentary rocks. Volcanic rocks, chiefly andesite and basalt of Tertiary and Quaternary age, locally overlie the formations of Late Jurassic and Late Cretaceous age. The Nakne formation of Late Jurassic age comprises a conglom erate unit overlain by 6,000 to 9,000 ft. of fossilife ous sandstone, siltstone, conglomerate, and shale. A new formation, the Kaguyak formation, of Late Cretaceous (Campanian-Maestrichtian) age is proposed. The formation has been divided into 3 infor al members: a lower + 2,000-ft. fossiliferous, silt stone member, a middle 1,090-ft. sandstone, silt stone, and shale member, and an upper +1,460-ft. littoral sandstone and siltstone member. A largely nonmarine coal-bearing formation at least 830 ft. thick, consists of conglomerate, sandstone, siltsto shale, and coal, and interfringes with layered volca rocks of Eocene age.

Seven northeastward-trending anticlines locally interrupt the regional southeasterly dip of the sedimentary rocks. The largest is the Kamishak anticline, whose crest is intruded by a quartz diorite stock. A reverse fault transects the mapped area from the Little Kamishak River to Contact Creek.

The rocks of the Naknek formation were derived

part from Lower and (or) Middle Jurassic intrusive ocks and were laid down as shelf deposits during a ansgression of seas during Late Jurassic time. he area was at a state of base level during most of retaceous time. The seas transgressed during ate Cretaceous time, and this was followed by a ajor regression of the seas permitting the area to merge completely during Eocene time. No major eformation occurred during Jurassic and Cretaceous me, and since then there has been only one major eriod of folding and faulting, probably after Eocene nd before Quaternary time.

Sedimentary rocks of the Naknek and Kaguyak for-ations may serve as both a source and a reservoir or petroleum. Locally, structural and stratigraphic raps may also be present. Any exploitation of the rea for petroleum seems remote, however, and robably should not be attempted until such time as rilling in more favorable localities N. and S. of the lount Katmai area delimits the petroleum possibil-ies of the sedimentary rocks. --Auth.

-2692. Mudge, Melville R., Charles P. Walters, nd Ralph E. Skoog. GEOLOGY AND CONSTRUC-ION-MATERIAL RESOURCES OF NEMAHA COUNTY, ANSAS: U.S. Geol. Survey, Bull. 1060-D, p. 179-56, 2 maps (1 col. in pocket, scale 1:63,360), sec. n pocket), 2 graphs, table, 1959, 16 refs.

Nemaha County lies in the northernmost tier of ansas counties and is in the third tier W. of Mis-ouri. This county is mantled almost entirely by uaternary surficial deposits but sedimentary bed-ock crops out in some of the major stream valleys.

The surficial deposits consist mostly of glacial eposits of Kansan age that are as much as 300 ft. ick. These deposits are mainly glacial till with enses of outwash gravel. Galciolacustrine deposits nostly silt) are found in small areas in southern emaha County. Overlying the glacial sediments are in deposits of loess of Illinoian and Wisconsin age. errace material and colluvium are present in almost ll of the valleys. Only the outwash gravel and laciolacustrine deposits are presently (1956) of eco-omic importance as engineering construction mate-ials.

The bedrock crops out mainly in northern Nemaha ounty. These rocks range from the Topeka lime-tone of late Pennsylvanian age to and including the Vreford limestone of early Permian age. The lime-tones of Pennsylvanian age that are being used as onstruction material are the Church limestone mem-er of the Howard limestone, the Reading and Elmont imestone members of the Emporia limestone, and he Tarkio limestone member of the Zeandale lime-tone. The limestones of Permian age that are being sed as construction material are the Neva limestone nember of the Grenola limestone and the Cottonwood imestone member of the Beattie limestone. --Auth.

-2693. Bayley, Richard W. GEOLOGY OF THE LAKE MARY QUADRANGLE, IRON COUNTY, MICH-GAN: U.S. Geol. Survey, Bull. 1077, p. 1-112, 24 llus., 8 maps, 3 diags., 7 pls. (under separate cov-r) incl. 6 maps (geol. map scale 1:24,000), profiles, 959, 26 refs.

The Lake Mary quadrangle is in eastern Iron ounty, in the W. part of the Upper Peninsula of lichigan. The quadrangle is underlain by lower and iddle Precambrian rocks formerly designated Archean nd Algonkian rocks, and is extensively covered by leistocene glacial deposits. A few upper Precam-brian (Keweenawan) diabase dikes and 2 remnants of sandstone and dolomite of early Paleozoic age are also found in the area.

The major structural feature is the Holmes Lake anticline, the axis of which strikes NW. through the NE. part of the quadrangle. Most of the quadrangle, therefore, is underlain by rock of the W. limb of the anticline. To the NW. along the fold axis, the Holmes Lake anticline is separated from the Amasa oval by a saddle of transverse folds in the vicinity of Michi-gamme Mountain in the Kiernan quadrangle.

The lower Precambrian rocks are represented by the Dickinson group and by porphyritic red granite whose relation to the Dickinson group is uncertain, but which may be older. The rocks of the Dickinson group are chiefly green to black metavolcanic schist and red felsite, some of the latter metarhyolite. The dark schist is commonly magnetic. The Dickinson group underlies the core area of the Holmes Lake anticline, which is flanked by steeply dipping middle Precambrian formations of the Animikie series.

A major unconformity separates the lower Precam-brian rocks from the overlying middle Precambrian rocks. In ascending order the formations of the mid-dle Precambrian are the Randville dolomite, the Hem-lock formation, which includes the Mansfield Fe-bearing slate member, and the Michigamme slate. An unconformity occurs between the Hemlock forma-tion and Michigamme slate. The post-Hemlock un-conformity is thought to be represented in the Lake Mary quadrangle by the absence of Fe-formation of the Amasa formation, which is known to lie between the Hemlock and the Michigamme to the NW. of the Lake Mary quadrangle in the Crystal Falls quadrangle. Post-Hemlock erosion may account also for the ab-sence of Fe-formation of the Fence River formation on the E. limb of the Holmes Lake anticline within the Lake Mary quadrangle.

The Randville dolomite is not exposed and is known only from diamond drilling in the NE. part of the area where it occurs in the E. and W. limbs of the Holmes Lake anticline. The formation has a maximum thick-ness of about 2,100 ft.; this includes a lower arkosic phase, some of which is quartz pebble conglomerate, a medial dolomitic phase, and an upper slate phase. The triad is gradational. Included within the forma-tion are a few beds of chloritic schist thought to be of volcanic origin. An unconformity between the Randville and the succeeding Hemlock is not indicated in the quadrangle, but is probably present.

The Hemlock formation is best exposed in the NW. and S.-central parts of the area. The apparent thickness of the formation is 10,000-17,000 ft. It is composed mainly of mafic metavolcanic rocks and in-tercalated slate and Fe-formation. In the N. part of the quadrangle the volcanic rocks are greenstone, which includes altered basaltic flow rocks, volcanic breccia, tuff, and slate. Pillow structures are com-mon in the metabasalt. It is not certain if any Hem-lock rocks are present in the E. limb of the Holmes Lake anticline. In the S. part of the quadrangle, the rocks of the Hemlock are chiefly chlorite and horn-blende schist and hornfels. Pyroxene hornfels is sparingly present.

At least 2 sedimentary slate belts are included in the Hemlock formation. One of these, the Mansfield Fe-bearing slate member, includes in its upper part an altered chert-siderite Fe-formation 30 to over 150 ft. thick from which Fe ore has been mined at the Mansfield location. The position of the Fe-bear-ing rocks has been determined magnetically, and past explorations for Fe ore are discussed.

Though probably unconformable, the contact be-

tween the Hemlock and the Michigamme formations appears conformable. The Michigamme slate consists of at least 4,000 ft. of interbedded mica schist and granulite, the altered equivalents of the slate and graywacke characteristic of the Michigamme in adjacent areas. The Michigamme rocks are best exposed in the S. part of the quadrangle in the vicinity of Peavy Pond.

Two periods of regional metamorphism have resulted in the alteration of almost all of the rocks of the quadrangle. The lower Precambrian rocks underwent at least one period of metamorphism, uplift, and erosion before the deposition of the Randville dolomite. After the deposition of the Michigamme slate, a post-middle Precambrian period of regional metamorphism occurred, with attending deformation and igneous intrusion. The grade of metamorphism rises toward the S. in the area. The rocks in the northern two-thirds of the quadrangle are representative of greenschist facies of regional metamorphism, whereas the rocks in the southern one-third of the quadrangle are representative of the albite-epidote-amphibolite, the amphibolite, and the pyroxene hornfels facies, the metamorphic node centering about the intrusive Peavy Pond complex in the Peavy Pond area.

The Precambrian sedimentary and volcanic rocks are cut by intrusive igneous rocks of different types and several different ages. Gabbroic sills and dikes invaded the Hemlock rocks at some time after the Hemlock was deposited and before the post-middle Precambrian orogeny and metamorphism. Some contact metamorphism attended the intrusion of the major sills. One of the sills, the West Kiernan sill, is well differentiated. A syntectonic igneous body, composed of gabbro and minor ultramafic parts and fringed with intermediate and felsic differentiates and hybrids, the Peavy Pond complex, was intruded into the Hemlock and Michigamme formations during the post-middle Precambrian orogeny. The complex is situated in the Peavy Pond area at the crest of the regional metamorphic node. Contact-altered sedimentary and volcanic rocks margin the complex.

The effects of regional metamorphism have been superposed on the contact metamorphic rocks peripheral to the complex and on the igneous rocks of the complex as well. The mafic augite-bearing rocks of the complex emplaced early in the orogeny were deformed by granulation at the peak of the deformation and subsequently metamorphosed to hornblende rocks. Some of the intermediate and felsic rocks of the complex were foliated by the deformation, while the more fluid, felsic parts of the complex were intruded under orogenic stress and crystallized after the peak of deformation. The deformation culminated in major faulting during which the formations were dislocated, and some of the granite of the complex was extremely brecciated.

A few diabase dikes, probably of Keweenawan age, have intruded the deformed and altered Animikie rocks.

The only known metallic resource is Fe ore. The Mansfield mine produced 1 1/2 million tons of high-grade Fe ore between the years 1890 and 1913. Sporadic exploration since 1913 has failed to reveal other ore deposits of economic importance. --Auth.

1-2694. Johns, Willis M. PROGRESS REPORT ON GEOLOGIC INVESTIGATIONS IN THE KOOTENAI-FLATHEAD AREA, NORTHWEST MONTANA. I, WESTERN LINCOLN COUNTY: Montana Bur. Mines & Geology, Bull. 12, 56 p., 9 pls. incl. 2 maps, scale 1:63,360 and 1:126,720, 1959.

The area mapped, the S. half of the Yaak River 30-min. quadrangle, is about 440 sq. mi. and lies at the southern end of the Purcell Mountains. The ultimate purpose of the program is to map the areal geology and determine the economic mineral potential of northwestern Montana included in Lincoln, Flathead, and northern Lake counties.

The area so far mapped is underlain by sedimentary rocks of the Belt series of Precambrian (Algonkian?) age including the Prichard formation, Ravalli group, Piegan group (Wallace limestone and associated rocks), and the Missoula group (Striped Peak and Libby formations). Quartzites and quartzitic argillites dominate in the Prichard formation and Ravalli group. The Piegan group is characterized b limestones and argillite. The Striped Peak formatio is quartzite and argillite, and the Libby formation i argillite and magnesian limestone. These rocks were formed by static metamorphism from sands, clays, and calcareous muds deposited in a shallow sea from a source to the W.

During the Laramide orogeny, Belt rocks were compressed into northwesterly trending folds. E. and NE. faults, later than NW. normal faults, may be complementary shears. A fourth group strikes N.-S. Faulting has been active during recent geologic times.

Au-quartz, Pb-Ag-Zn, and sparse Cu mineraliza tion has occurred in veins filling pre-existing faults and shear zones in metadiorite dikes and sills, and in Belt sediments during late Cretaceous or early Tertiary times. --Auth.

1-2695. Hammond, C.R., and Henry Trapp, Jr., ed BILLINGS GEOLOGICAL SOCIETY 10TH ANNIVERSARY FIELD CONFERENCE, AUGUST 13-15, 1959. SAWTOOTH-DISTURBED BELT AREA: 208 p., illus maps (3 in pocket), charts, secs. (3 in pocket), diag (1 in pocket), graphs, logs, [Billings, Montana, Billings Geological Society], 1959, refs.

The guidebook covers "the general area of the Sawtooth Mountains and adjacent disturbed belt of NW. Montana. The purpose of the trip is to better acquaint the participants with the stratigraphy of the general area and to point out some of the complex structures associated with the disturbed belt and ove thrust areas. Prolific gas production in a similar structural setting to the N. in Canada, the recent ga discovery at Blackleaf Canyon field, plus the continuing encouragement encountered on the Sweetgrass arch have given considerable impetus to exploration in the area of this field conference."

The route of the field conference passes over "th gentle structures of the Sweetgrass arch, through th complexly folded and faulted Mesozoic sediments of the disturbed belt, and finally into the zone of multiple thrusting in the Paleozoics and Mesozoics of the Sawtooth Mountains." Sediments ranging in age from the Precambrian belt series to Tertiary are covered; special emphasis is placed on sediments of primary interest to the oil industry. --From introd.

The papers are listed below; those with capitalized titles are abstracted separately in the order in which they appear in the guidebook.

HISTORICAL

Dockery, W. Lyle. Scenes in the Land of the Chinook, p. 11-16.

TECHNICAL SECTION

Penetration Chart of Montana Oil and Gas Fields, between p. 16-17.

Correlation Chart, Montana and Adjacent Areas, p. 17.

Stratigraphic Cross Sections, in pocket.

Structural Geology

Mudge, Melville R. A BRIEF SUMMARY OF THE GEOLOGY OF THE SUN RIVER CANYON AREA, p. 18-22.

Poulter, Glenn J. STRUCTURAL SYNTHESIS OF AN AREA IN SOUTHEASTERN GRANITE COUNTY, MONTANA, p. 23-33.

Robinson, G. D. THE DISTURBED BELT IN THE SIXTEENMILE AREA, MONTANA, p. 34-40.

Stratigraphy

Achauer, Charles W. STRATIGRAPHY AND MICROFOSSILS OF THE SAPPINGTON FORMATION IN SOUTHWESTERN MONTANA, p. 41-49.

Fish, Andrew R., and John C. Kinard. MADISON GROUP STRATIGRAPHY AND NOMENCLATURE IN THE NORTHERN WILLISTON BASIN, p. 50-58.

Lewis, Paul J. MISSION CANYON BIOHERMS OF NORTHEAST MONTANA, p. 59-63.

Blake, Oliver D. BIG SNOWY STRATIGRAPHY IN THE AREA ADJACENT TO THE ROCKY MOUNTAIN FRONT, p. 64-68.

Todd, Donald F. THE LOWER TYLER OF CENTRAL MONTANA, p. 69-74.

Ramsey, R. D. THE AMSDEN FORMATION IN THE WOLF SPRINGS-DELPHIA AREA OF CENTRAL MONTANA, p. 75-83.

Weimer, Robert J. JURASSIC-CRETACEOUS BOUNDARY, CUT BANK AREA, MONTANA, p. 84-88.

Cobban, W. A., Charles E. Erdmann, Richard W. Lemke, and Edwin K. Maughan. COLORADO GROUP ON SWEETGRASS ARCH, MONTANA, p. 89-92.

Petroleum Geology

Gribi, Edward A., Jr. OIL DEVELOPMENT AND PROSPECTS OF SOUTH SWEETGRASS ARCH AREA, p. 93-97.

Hurley, G. William. OVERTHRUST FAULTING AND PALEOZOIC GAS PROSPECTS IN MONTANA'S DISTURBED BELT, p. 98-108.

Wetzel, John H. WELL LOG PROGRAMING, p. 109-111.

Williams, James F. Delphia Field, Musselshell County, Montana, p. 112-113.

Lowe, Howard R. Red Creek Field, p. 114-123.

Staggs, James O. Stensvad Field, p. 124-128.

Mining

Sahinen, Uuno M. Metalliferous Deposits in the Helena Area, Montana, p. 129-140.

ROAD LOGS

Entrance Road Log

Krein, F. P., John R. Warne, and James L. Cannon. U. S. Highway 87, Eddie's Corner to Great Falls, p. 142-146.

First Day

Erdmann, Charles E. Geologic Road Log, Great Falls to Augusta, Via U. S. Highway 89 and Montana Routes 20 and 21, p. 147-153.

Mudge, Melville R., and Ernest Dobrovolny. Road Log - Augusta to Gibson Reservoir, p. 155-158.

Second Day

Erdmann, Charles E. Geologic Road Log, Augusta to Wolf Creek, Via Montana Route 287, p. 159-163.

Widmer, H. Road Log, Montana No. 20, Bowmans Corner to Rogers Pass, p. 164-165.

Erdmann, Charles E. Geologic Road Log, Wolf Creek to Helena, Montana, Via U. S. Highway No. 91, p. 166-170.

Erdmann, Charles E. Geologic Road Log, Helena Over McDonald Pass, Via U. S. Highway 10 N. and Return Via Mullen Pass and Austin, p. 171-177.

Third Day

Road Log, Helena to Townsend, p. 178-182.

Robinson, G. D. Road Log - Townsend to Lombard and up Lower Sixteen Mile Creek, p. 183-185.

Exit and Supplemental Road Logs

Aalseth, Earl P., and Howard W. Lorenz. State Highway No. 6 and U. S. Highway 89, Townsend to White Sulphur Springs, p. 186-187.

Erdmann, Charles E. Montana Route No. 20, Simms to Bowmans Corner, p. 188-191.

Egbert, Robert L., and R. C. Heins. Augusta - Ford Creek - Wood Canyon (Bench Mark Road), p. 192-194.

1-2696. Mudge, Melville R. A BRIEF SUMMARY OF THE GEOLOGY OF THE SUN RIVER CANYON AREA (In: Hammond, C. R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 18-22, illus., map (in pocket, scale approx. 2 3/4 in. to 1 mi.), table, [Billings, Montana, Billings Geological Society], 1959) 15 refs.

The structure of the Sun River Canyon area E. of Gibson dam to a point about 4 mi. E. of Diversion dam is divisible into 3 units, each with characteristic structural and stratigraphic elements. Faults, mostly thrusts, show decreasing displacement from W. to E. but increasing steepness of dips. Large folds are absent in the western area. They are closed and slightly overturned and few in the central area. They are open, symmetical, and abundant in the eastern area.

The structures N. of the river trend essentially due N.; those S. of the river about S. 25°E. The Sun River, therefore, is incised along an E.-W. zone of weakness where the trend changes.--Auth. summ.

1-2697. Poulter, Glenn J. STRUCTURAL SYNTHESIS OF AN AREA IN SOUTHEASTERN GRANITE COUNTY, MONTANA (In: Hammond, C. R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 23-33, 4 maps, chart, 7 secs., [Billings, Montana, Billings Geological Society], 1959) 26 refs.

Sedimentary rocks in southeastern Granite County consist of thick sequences of competent limestones and quartzites, with thin incompetent shale intervals. At the onset of the Laramide orogeny these beds were essentially horizontal, and deformation was accomplished by diagonal shearing across competent beds and by bedding-plane slip in the incompetent strata.

This displacement alone produced the initial folds in the overthrust mass. As frictional resistance halted movement along the thrust plane, the truncated competent beds acted as a buttress to the compressive stresses, and folding was initiated in the underlying mass. This initial displacement along the Georgetown thrust is considered to have occurred during the mid-Laramide orogenic phase (late Paleocene). During a later and more intense compressional phase further displacement occurred along the Georgetown thrust. This movement was along the earlier thrust plane except that the buttressing effect of the truncated competent beds was removed, and the top portion of the down-folded strata in Rock Creek syncline was sheared off. This later deformation is considered to have taken place during a late Laramide (early? Eocene) phase of compression and reflects a release of stresses which had developed as a result of left-lateral movement along the Montana lineament. This release of stresses S. of the lineament, combined with a strong force component directed at right angles to the lineament produced some overriding to the N. of the transverse zone by the thrust plate. In middle Eocene time emplacement of the granitic rocks in the southern portion of the area imparted a northward plunge to the structures, and normal faults developed transverse to the structures in post-Miocene time. --Auth. summ.

1-2698. Robinson, G.D. THE DISTURBED BELT IN THE SIXTEENMILE AREA, MONTANA (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 34-40, 2 maps, chart, 2 fold. secs., [Billings, Montana, Billings Geological Society], 1959) 13 refs.

The structure and, to a lesser extent, the stratigraphy at the S. end of Townsend Valley and along lower Sixteenmile Creek, near the head of the Missouri River is discussed. In an area of less than 50 sq. mi., virtually the entire spectrum of geomorphic, stratigraphic, and structural elements of the disturbed belt is on spectacular display. This paper sketches the bedrock geology of the area, called for convenience the Sixteenmile area. The disturbed belt is a loose term for the variably broad sinuous zones of intricately folded and faulted rocks that stretches for more than 350 mi. along the eastern front of the Northern Rocky Mountains in southern Alberta and western Montana.

Geomorphically the Disturbed belt is marked by long high sharp-crested ranges trending a little E. or W. of N., separated by flat-floored valleys, elongated parallel to the ranges. Stratigraphically, the ranges are characterized by thick marine deposits ranging in age from late Precambrian to late Jurassic, but with few or no Ordovician, Silurian, Permian, or Triassic rocks; continental deposits of Late Jurassic and Early Cretaceous age; and a wide variety of Late Cretaceous marine and continental sedimentary rocks and land-laid volcanics. Structurally, the most striking features of the ranges are W.-dipping thrust faults. The maximum stratigraphic throw on many thrusts is on the order of 10,000 ft., generally with Belt series overriding Cretaceous rocks. The rocks of the region have also been intensely folded along axes roughly parallel to the traces of the thrusts. The folding and thrusting developed largely in very late Cretaceous and Paleocene ("Laramide") time and was accompanied by minor intrusions of calc-alkaline rocks. In the Disturbed belt Precambrian rocks are rarely brought to the surface, indicating that the deformation was shallow-seated and suggesting that, whatever the local surface of thrusting, the main surface of movement was within the Belt series or along the major unconformity at its base. --From auth. introd.

1-2699. Achauer, Charles W. STRATIGRAPHY AND MICROFOSSILS OF THE SAPPINGTON FORMATION IN SOUTHWESTERN MONTANA (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 41-49, 5 illus., fold. diag., [Billings, Montana, Billings Geological Society], 1959) 20 refs.

The conodont fauna of the Sappington lower black shale is not comparable with other conodont fauna from black shales at the Devonian-Mississippian contact in other parts of Montana. Hence, the Sappington lower black shale is apparently restricted to southwestern Montana.

The Sappington middle member disappears rapidly from the section in several directions. No evidence was seen in any exposure to indicate that this abrupt disappearance is due to interfingering or facies changes. Instead, it is suggested that the Sappington middle member may have once been continuous with silty and sandy beds at the Devonian-Mississippian boundary in other parts of western Montana. Subsequent erosion prior to deposition of the Lodgepole formation may have left isolated remnants of silty and sandy beds which today have no apparent lateral connection.

The age of the Sappington is uncertain. More exacting work is needed for the determination of the ranges and the stratigraphic occurrences of fossils in the Three Forks-Sappington interval. However, Cyrtiopsis appears to be limited to the Three Forks and Syringothyris is characteristic of the Sappington.

Fossil spore studies indicate that notable differences exist between spore assemblages of the lower black shale and spore assemblages of the upper black shale. These differences may prove helpful in correlating these black shales. Preliminary studies already indicate some correspondence in spore types between the upper black shale member and the black shale at the base of the Lodgepole formation in central Montana. --Auth. concl.

1-2700. Fish, Andrew R., and John C. Kinard. MADISON GROUP STRATIGRAPHY AND NOMENCLATURE IN THE NORTHERN WILLISTON BASIN (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 50-58, 4 maps (2 fold.), chart, sec. (in pocket), [Billings, Montana, Billings Geological Society], 1959) 8 refs.

In the area of the international boundary, in northern North Dakota, carbonates and evaporites of the Madison group [Mississippian] attain a maximum thickness in the central Williston basin near the town of Williston, North Dakota. Recent drilling has resulted in scores of Madison discoveries in the United States and Canada in which the oil trapping mechanism can be classified into one or more of the following: 1) predominantly structurally controlled pools, 2) tilted and truncated porous units sealed under a Triassic shale cap rock, and 3) updip porosity wedgouts resulting from facies change.

The area has gained prominence in recent years as a new province for stratigraphic oil exploration, and as such, offers the stratigrapher abundant opportunity to apply his ideas.

Considerable effort has been put forth by various

authors to introduce a system of nomenclature which is tenable throughout the basin. It is held that the use of local terminology, based on rock types, is a workable answer to the problem. Long range correlation is feasible with present well control. The stratigraphic relationships between the "east side" Williston basin truncation belt and the Poplar anticline of Montana are demonstrable. --Auth.

1-2701. Lewis, Paul J. MISSION CANYON BIOHERMS OF NORTHEAST MONTANA (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 59-63, 6 illus., fold. sec., [Billings, Montana, Billings Geological Society], 1959) 5 refs.

Certain stratigraphic zones have long been recognized in the Mission Canyon formation [Mississippian] of the Williston basin which do not conform to the normal pattern of sedimentation in an uninterrupted depositional environment. In order to establish accurately the various facies of the Mississippian carbonates in the Williston basin, an intensive rock thin-sectioning program was initiated in 1957. The recognition of and the detailing of the bioherms is a direct result of this program. Pray also experienced the difficulty of accurate analysis of the core rock and finally determined that thin-sections or polished sections were required in this problem.

Although the essential features of the bioherms have been established, much more detail work is needed in order to speed petroleum exploration of the bioherms. Since no surface exposures containing the bioherm facies outcrop in the Williston basin, the analysis must be made on subsurface sections.

The economic incentive to critically analyze the section is present as petroleum production is being and has been obtained from the facies of the bioherms, in Montana and North Dakota. It is essential to understand the facies relationships and the characteristics of each so as to pursue an intelligent and an economical exploration program. The methods of study will require techniques not in common use, but which are being employed by the more progressive exploration companies. --From auth. introd.

1-2702. Blake, Oliver D. BIG SNOWY STRATIGRAPHY IN THE AREA ADJACENT TO THE ROCKY MOUNTAIN FRONT (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 64-68, map, 3 secs., [Billings, Montana, Billings Geological Society], 1959) 12 refs.

In the central part of Montana, Upper Mississippian rocks of the Big Snowy group are well known from surface exposures and adequate well control. As this sequence is traced W. and southward from Fergus and Golden Valley counties, correlation becomes increasingly difficult. Locally the section becomes thicker but generally there is a gradual thinning of the sequence, and the lithologic changes that occur make it impossible to apply all of the Big Snowy formational names of central Montana to equivalent rocks in the vicinity of the Rocky Mountain front. In the critical area of this lithologic change in Meagher and Broadwater counties there are few surface exposures of these rocks, for in the mountainous parts of this area the exposures are dominantly Precambrian or igneous rocks, and in the intervening valleys a thick fill covers the underlying strata. There are, however, sufficient exposures or wells in the surrounding area to permit broad interpretations of the Big Snowy stratigraphy in this part of Montana. --Auth. introd.

1-2703. Todd, Donald F. THE LOWER TYLER OF CENTRAL MONTANA (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 69-74, 2 illus., 2 maps, 2 secs., graph, log, [Billings, Montana, Billings Geological Society], 1959) 10 refs.

This area in central Montana comprises approximately 1,000 sq. mi.; it is that part of the Big Snowy uplift which has been found productive in the Mississippian sediments, most commonly known as lower Tyler. The sands of the lower Tyler are currently the prime objectives of central Montana, producing oil at Sumatra, Stensvad, Ivanhoe, Melstone, and Big Wall fields. The lower Tyler is defined and described, and an attempt is made to explain the nature of its occurrence. Tectonic and stratigraphic clues are believed to exist, which, if used skillfully, should lead to the discovery of additional oil in this zone. --From auth. introd.

1-2704. Ramsey, R.D. THE AMSDEN FORMATION IN THE WOLF SPRINGS-DELPHIA AREA OF CENTRAL MONTANA (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...; p. 75-83, 6 maps, 2 secs., [Billings, Montana, Billings Geological Society], 1959) 5 refs.

The Amsden formation [Pennsylvanian] thins progressively northward by pre-Piper truncation. This can be demonstrated by stratigraphic cross sections. By means of the same medium it can be shown that the Custer anticline and the Delphia structure were both relatively high in pre-Piper time, because the Amsden at both places is thinner than that in nearby off-structure wells. This gives evidence for postulating that these 2 Laramide structures had some expression in post-Amsden, pre-Piper time. The same "thins" show up in Amsden isopachous maps.

The Amsden formation in central Montana produces commercial quantities of oil at Wolf Springs, Delphia, Gage, and Big Wall fields. Stratigraphic studies of the productive intervals at Wolf Springs and Delphia and the surrounding area show that reservoir space in the form of vugs and fractures has been developed in the dense upper dolomite portion of the Amsden. Development of such vugular porosity came about as a result of the dolomite being exposed to a prolonged period of pre-Piper subaerial erosion in this general area. Fracturing along pre-Laramide structural highs (later modified by Laramide folding) provided solution channels for ground-water movement. Typically, the Amsden pay is a dense, light colored dolomite, often cherty, vuggy and fractured. It is sometimes breccialike in appearance and may include chert in the form of irregular inclusions and vug linings. Very little, if any, porosity is intercrystalline.

Subdivision of the Amsden is possible by the use of electric logs. The Amsden can be divided into upper and lower units stratigraphically on the basis of picking a persistent low resistivity kick as the dividing line. Both zones produce oil. Either can be considered a possible reservoir, depending on whether that part of the section is subjacent to the Piper and hence was exposed at the unconformity surface by erosion. --Auth.

1-2705. Weimer, Robert J. JURASSIC-CRETACEOUS BOUNDARY, CUT BANK AREA, MONTANA

(In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 84-88, 2 maps, secs., [Billings, Montana, Billings Geological Society], 1959) 2 refs.

If the correlations and interpretations on the cross sections are correct, the Jurassic-Cretaceous boundary is as high stratigraphically as the base of the L-M (Lander-Moulton) zone. From work now in progress, regional correlations of the L-M zone with marine Jurassic sediments on the E. flank of the Kevin-Sunburst dome suggest that the systemic boundary may be above the L-M zone within the nonmarine Kootenai formation. --Auth.

1-2706. Cobban, W.A., Charles E. Erdmann, Richard W. Lemke, and Edwin K. Maughan. COLORADO GROUP ON SWEETGRASS ARCH, MONTANA (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 89-92, map, chart, [Billings, Montana, Billings Geological Society], 1959) 8 refs.

Rocks formerly assigned to the Colorado shale [Cretaceous] have been subdivided recently by the writers into a lower unit, the Blackleaf formation, with 4 named members, and an upper unit, the Marias River shale, with 4 named members. The members of the Blackleaf formation are the Flood, Taft Hill glauconitic, Vaughn bentonitic, and Bootlegger. The Floweree, Cone calcareous, Ferdig shale, and Kevin shale comprise the Marias River shale. --From auth. introd.

1-2707. Gribi, Edward A., Jr. OIL DEVELOPMENTS AND PROSPECTS OF SOUTH SWEETGRASS ARCH AREA (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 93-97, map (in pocket, scale approx. 1 in. to 2 mi., contour interval 500 ft.), chart, [Billings, Montana, Billings Geological Society], 1959).

This paper describes the oil and gas development of that portion of the Sweetgrass arch and Disturbed belt of Montana lying between the S. limits of Cut Bank and Kevin-Sunburst fields and the Belt Mountain uplift. The area is bounded on the W. by the older outcrops in the mountainous core of the Disturbed belt and stretches eastward about 80 mi. to a line which is 30 to 40 mi. E. of the crest of the arch. Geologic details are not discussed, the purpose being to present the economic aspects of the S. arch area.

A map of the area with contours on top of the Madison is included. A chart showing the number of wildcat wells that bottomed in or drilled through each horizon gives a rough idea of the proportion of oil shows encountered and wells that produced some oil from each formation. --From auth. introd.

1-2708. Hurley, G. William. OVERTHRUST FAULTING AND PALEOZOIC GAS PROSPECTS IN MONTANA'S DISTURBED BELT (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 98-108, 5 maps, chart, 8 secs., log, [Billings, Montana, Billings Geological Society], 1959).

The Disturbed belt of Montana lies on the hingeline between the central stable platform on the E. and the Rocky Mountain geosyncline on the W. It lies W. of the Sweetgrass arch and includes the Rocky Mountain front ranges of western Montana. It is characterized by a zone of overthrust faulting and folding extending from the Missouri River northward 125 mi. to the International Border.

Structurally the Disturbed belt is divisible into 3 layers, a regional layer, a high-angle thrust layer, and a low-angle thrust layer. The regional layer is the oldest and comprises the W. flank of the Sweetgrass arch over which the younger high-angle thrust layer has ridden. The high-angle thrust layer is complexly imbricated and constitutes the typical Disturbed belt structures. The low-angle thrust layer, commonly known as the Lewis overthrust, is the youngest layer and has overridden the high-angle thrust layer. Subsequent high-angle block faulting has added further complexity to the structures.

Three types of traps have been recognized in Montana's Disturbed belt. Type no. 1 is the fault traps on the wedge-edge of the Paleozoic thrust sheets; type no. 2 is the drag folds formed as the result of thrusting; and type no. 3 is the folds occurring W. of the zone of drag folding. Northern Natural Gas Producing Company's recent Mississippian discovery in sec. T26N, R9W, in Teton County is the first evidence that commercial hydrocarbon accumulations exist in Montana's Disturbed belt. This discovery is of the wedge-edge type. --Auth.

1-2709. Wetzel, John H. WELL LOG PROGRAMING (In: Hammond, C.R., and Henry Trapp, Jr., eds. Billings Geological Society 10th Anniversary Field Conference...: p. 109-111, [Billings, Montana, Billings Geological Society], 1959) 8 refs.

Selection of an appropriate primary logging program as well as the subsequent interpretation has become an increasingly important function of the petroleum geologist and petroleum engineer. Increased emphasis upon programing is a direct or indirect consequence of a number of factors, among these 1) improvement and development of advanced equipment, 2) new interpretation techniques, 3) increased reliance upon both qualitative and quantitative log interpretation, and 4) rising formation evaluation costs.

A primary well logging program is defined as one in which electrical and/or radioactive devices are run in open fluid-filled holes. In general the objective of such a program is to provide maximum reliable formation evaluation at minimum cost. Discussion will be limited to those types of logs currently available to industry in this area.

Selection of a proper logging program requires a prudent examination of geological, engineering, and economic factors. Factors which warrant prime consideration are 1) the anticipated or actual mud program, including cake and filtrate characteristics, 2) the lithology and, in many instances, particular lithologic combinations, 3) the anticipated extent of filtrate invasion, 4) the desired qualitative as well as quantitative data, and 5) the logging costs inclusive of rig time. --Auth.

1-2710. Wherry, Edgar T. SUCCESSIVE GEOLOGIC MAPS OF BUCKINGHAM MOUNTAIN: Pennsylvania Acad. Sci., Proc., v. 33, p. 195-197, 1959.

Buckingham Mountain is a ridge standing about 200 ft. above surrounding lowlands some 6 mi. E. of Doylestown, Bucks County, Pennsylvania. In the course of mapping the Triassic rocks of this region for the Second Geological Survey of Pennsylvania, Lyman recognized it to represent a portion of the floor of the Triassic basin. His map, dated 1893, shows it to consist of Cambrian quartzite.

In 1907 the writer studied the area and found the NE. end to be a plunging anticline of quartzite, and the SW. end proved to consist of an anticline of quartzite underlain by gabbro. The gabbro extended over an area around 500 ft. wide and 800 ft. long. When the map was published in 1931 in U. S. Geological Survey Bulletin 828, the formation boundaries had been edited to accord with the rather crude topographic base. The main body of quartzite was shown as terminating short of the actual mapped area, and the gabbro was reduced to a tiny ellipse, most of its area being mapped as quartzite.

A geologic map of Bucks County was published by the Pennsylvania Topographic and Geologic Survey in 1953. The quartzite boundary on this map again was placed farther short of the 1931 mapping. The gabbro was omitted entirely.

Upon revisiting the area the author found an outcrop of solid quartzite well N. of the position shown on any of the maps referred to and could roughly trace the gabbro area by observation of vegetation cover. This area is large, not small. Preparation of still another geologic map of Buckingham Mountain should certainly be undertaken. --Auth.

1-2711. Ordway, Richard J. GEOLOGY OF THE BUFFALO MOUNTAIN-CHEROKEE MOUNTAIN AREA, NORTHEASTERN TENNESSEE: Tennessee, Dept. Conserv., Div. Geology, Rept. Inv. 9, 17 p., 3 illus., fold. geol. map (scale 1:24,000) and sec., 1959, 15 refs.; reprinted from: Geological Society of America, v. 70, no. 5, p. 619-635, May 1959.

Original paper was listed as GeoScience Abstracts 1-1362.

1-2712. Ingels, J.J.C. THE GEOLOGY OF THE LANCASTER QUADRANGLE OF DALLAS AND ELLIS COUNTIES, TEXAS: Field & Lab., v. 27, no. 1, p. 5-10, geol. map scale 1:31,680, Jan. 1959.

In the Lancaster quadrangle, the Austin chalk of Upper Cretaceous age is divisible into 3 members: the upper chalk, the middle marl, and the lower chalk. The contacts between members are gradational. Several scour-and-fill structures are exposed in the lower member. Quaternary terrace remnants consist mainly of cross-laminated sand intertongued with lenses of chalk gravel.

Several high-angle normal faults cross the area striking NE.-SW. One of these has a minimum displacement of 100 ft. where it crosses Bear Creek 1/2 mile E. of State Highway 342. Two others have minimum displacements of 40 ft., but most have offsets of a few feet. Joints striking NE.-SW. are abundant. The fractures are probably related to the Balcones system of central Texas. --Auth.

1-2713. Pitkin, James A. THE GEOLOGY OF THE PALMER QUADRANGLE, ELLIS COUNTY, TEXAS: Field & Lab., v. 26, no. 3/4, p. 75-84, geol. map, July-Oct. 1958, pub. 1959.

The 7 1/2-min. Palmer quadrangle is on the Gulf Coastal Plain. Bedrock consists of the upper chalk member of the Austin chalk and the lower marl and Wolfe City sand members of the Taylor marl, all of Upper Cretaceous age. The Austin-Taylor contact is disconformable and marked by a reddish marl zone 1 in. thick. The zone contains abundant phosphate pebbles and phosphatized fossils. Several specimens of rare "brittlestars" or ophuroids were collected from the upper Austin. The lowest sandy bed is considered to be the basal unit of the Wolfe City member. --A. Richards.

2. GEOMORPHOLOGY

See also: Areal and Regional Geology 1-2685; Sedimentary Petrology 1-2861, 1-2866, 1-2875; Engineering Geology 1-2922, 1-2923.

1-2714. Chorley, Richard J., and L.S.D. Morley. A SIMPLIFIED APPROXIMATION FOR THE HYPSOMETRIC INTEGRAL: Jour. Geology, v. 67, no. 5, p. 566-571, 7 figs. incl. diags., graph, table, Sept. 1959, 3 refs.

The usual method for the calculation of the hypsometric integral is rather laborious. In this paper it is shown how a rapid and accurate estimate can be obtained when the drainage basin is approximated by a simple geometrical form. --Auth.

1-2715. Löve, Doris. THE POSTGLACIAL DEVELOPMENT OF THE FLORA OF MANITOBA: A DISCUSSION: Can. Jour. Botany, v. 37, no. 4, p. 547-585, 10 maps, chart, July 1959, 101 refs.

An attempt is made to establish the development of the flora of Manitoba, Canada, after the complete extermination by the Wisconsin glacier of any pre-existing vegetation.

Based upon geology, palynology, and floristics, a theory is constructed that the ice was at first followed by a cold (marsh) grassland, covering the bottom of the drained Lake Agassiz I, and a riverine spruce (-pine) parkland of western origin, which persisted throughout the Valders period and the damming up of Lake Agassiz II. Around 9,000 B.P. a deciduous forest flora started to fill in around the edges of Lake Agassiz II, and a pine-oak savanna occupied the drier portions of the upland. This flora reached its maximum north- and westwards distribution towards the peak of the Hypsithermal. Also during the Hypsithermal it is suggested that a western (-southwestern) prairie flora covered the bottom of the draining Lake Agassiz II, reaching its farthest extension towards the N. and E. During the same time, the Arctic flora expanded over the Hudson's Bay Lowland. The last part to be covered by vegetation seems to have been the zone now called taiga, probably as late as 3,000-4,000 years ago. The spruce forest and its undervegetation seems to have arrived both from the W. and from the E., and in recent times (from 2,000 to 3,000 B.P.) is in a stage of expansion, forcing itself into the deciduous zone, which in turn is expanding over the prairie, save for the checking activities of Man (fire and cultivation). --Auth.

1-2716. Pounder, E. R., and E. M. Little. SOME PHYSICAL PROPERTIES OF SEA ICE. I: Can. Jour. Physics, v. 37, no. 4, p. 443-473, 35 figs. incl. illus., diags., graphs, Apr. 1959, 16 refs.

This preliminary study is based mostly on work done at a shore station in Shippegan, New Brunswick, during the winter of 1956-1957, with some data from

an icebreaker expedition [H. M. C. S. Labrador, Halifax to eastern Canadian Arctic] in the summer of 1956. The Shippegan site had unrafted ice, tides of 5 ft. or less, and negligible fresh-water runoff. The thickness of the ice was about proportional to the square root of the freezing exposure. Tritium dating of sea ice is an unsatisfacory method because of variable tritium concentration in Arctic waters. The jaggedness of ice crystals is suggested as a measure combining effects of age and thermal regime. Measurements of specific gravity, salinity, electrical resistivity, and permeability profiles all show progressive changes in annual sea ice throughout the winter. The tensile strength of sea ice at -20°C. was around 200 to 500 p. s. i., at various angles to the grain. For fresh-water ice, with stress parallel to the grain, it was in the range 500 to 1,000 p. s. i. Shear strengths, with the shear plane parallel to the grain, were 80 to 160 p. s. i. for sea ice at -20°C. and 160 to 280 p. s. i. for pond ice, also at -20°C. --Auth.

1-2717. Nakaya, Ukichiro. VISCO-ELASTIC PROPERTIES OF SNOW AND ICE IN THE GREENLAND ICE CAP: U.S. Snow, Ice & Permafrost Research Establishment, Research Rept. 46, 33 p., 21 illus., diag., 27 graphs, 2 tables, May 1959, 16 refs.

A newly designed portable visco-elastic meter was used to study snow and ice in Greenland. Ice samples from the ice tunnel at TUTO, core samples obtained by drilling in the ice cap at Site 2, and snow samples from near the surface of the ice cap were examined. The temperature and frequency dependence of Young's modulus and viscosity of tunnel ice were studied in the U. S. A. SIPRE laboratory.

The sample was cut in the shape of a rectangular bar and the resonance frequence of its bending vibration was measured for the calculation of Young's modulus, E. The loss factor tan δ was measured from the damping, and the coefficient of viscosity η was calculated, using the Maxwell model, from

$$\eta = \frac{E}{\omega \tan \delta}$$

where ω is the angular frequency.

On the basis of the Young's modulus-density relationship, the whole range of snow and ice observable in the Greenland Ice Cap can be divided into 3 regions, each of which shows a different elastic nature. In region I, density 0.917-0.90 g./cm.^{3}, Young's modulus decreases very rapidly when the density deviates slightly from that of pure ice. In region II, density 0.90-0.50 g./cm.^{3}, the relation is linear: $E = (16.4\rho - 7.20)\ 10^{10}$. In region III, density 0.50-0.25 g./cm.^{3}, Young's modulus decreases in an exponential form: $E = C \exp\{-k(0.50-\rho)\}$. The structure factor k is 6.35 for ordinary settled snow, smaller for wind-packed snow, and larger for granular snow.

The frequency dependence of Young's modulus is complicated but not very great. The frequency dependence of viscosity calculated by the Maxwell model is negligible, and a simple relation is observed between log η and δ. Log η decreases linearly with decrease in density to 0.55. Below density 0.50 g./cm.^{3}, another linear relationship is observed with a steeper slope. Thus Young's modulus and viscosity show similar behavior as a function of density.

Young's modulus shows a slight increase as the temperature decreases. Viscosity η increases in an exponential form with decrease in temperature. The activation energy was calculated from the log vs. 1/T curve, which is a straight line, and it was found that the value for old ice-cap ice was 18.7 kcal/mol, which is much larger than that of ordinary ice. --Auth. summ.

1-2718. Handy, R. L. THE EARTHWORM THEORY: Science, v. 130, no. 3383, p. 1162, Oct. 30, 1959.

Objections to theories explaining many glacial deposits as having been rafted by icebergs is emphasized by the satirical expounding of a "mechanism," the earthworm theory, which could as adequately explain these features. --M. Russell.

1-2719. Goldthwait, Richard P. SCENES IN OHIO DURING THE LAST ICE AGE: Ohio Jour. Sci., v. 59, no. 4, p. 193-216, 14 figs., July 1959, 52 refs.

Today's glaciers can tell us of ice age events by applying the principle of uniformitarianism if we assume that some conditions which obtain in present glaciated regions are similar to those of Wisconsin time in Ohio.

The pre-Wisconsin glacial land surface in Ohio was gently undulating or flat; the deep preglacial bedrock valleys were already filled by glacial deposits. The spotty grouping of spruce logs in the drift suggests that trees were in patches, and tree size suggests an open forest association such as is now found in Quebec where the July daily temperature is near 55°F. The ice added a veneer of till to the relatively smooth earlier glacial deposits, smearing down the till in the moving ice, as evidenced by oriented pebbles.

The source of most of this ice lay N. of Toronto as shown by pebbles in the till. Lake Erie shunted the ice southwestward into western Ohio, the flow being divided into lobes by high bedrock areas such as the Bellefontaine outlier. A decrease in tree ring growth in the outer rings of buried logs suggests that the ice edge advanced 38 ft. per year in Butler and Ross counties, and radiocarbon dates of these same logs afford an independent estimate of a rate of 55 ft. per year in the lower Scioto lobe, 108 ft. per year in the Miami lobe, and 390 and 310 ft. per year from Cleveland to Sidney and Columbus.

The several lobes in Ohio reached their maximum positions at dates 1,400 years apart, the interlobate areas being invaded first from one side, then from the other. In the summer, surface snow over the glacial ice melted back in a 50-mi. wide zone from the southern margin of the ice. Snow which accumulated in the Erie basin took less than 1,000 years to reach the heavy melting zone near Columbus or Dayton and moved at least 2 ft. a day on the surface in order to advance the margin 350 ft. per year even while it melted. From measurements in Greenland, Iceland, and Antarctica, one might estimate 3,000 ft for the depth of ice formerly over Columbus or Dayton and at least 5,000 ft. over the Lake Erie basin.

Geological evidence indicates that the last ice sheet receded in the face of a very mild climate. Spruce and hemlock grew in groups right at the ice edge and spread northward over glaciated western Ohio as the ice left. Rapid melting all over the surface produced wholesale thinning of the glacier. The outstanding deposit of such areas is the glacial kame. The 8 Ohio eskers are records of meltwater pouring through ice tunnels. Glacial outwash rivers overloaded with rock flour, sand, and gravel produced extensive valley trains at several levels in S.-trending valleys.

Halts in the retreat of the ice edge are clearly expressed by belts of end moraine hung like festoons across the glacial map of Ohio. These moraines are larger than any being produced by present-day glaciers. Deglaciation of Ohio was accomplished in 2,700 years according to radiocarbon data, part of which time was absorbed by halts when the moraines

were built. Evidences of long halts are windblown loess on top of some Wisconsin drift and variation in soils caused by the different lengths of time available for soil information. --P. Smyth.

1-2720. Forsyth, Jane L. THE BEACH RIDGES OF NORTHERN OHIO: Ohio, Div. Geol. Survey, Inf. Circ. no. 25, 10 p., 5 figs., 2 maps, 1959, 7 refs.

A series of sandy ridges in northern Ohio represents beaches deposited by a sequence of lakes which were present in the Lake Erie basin during late glacial times. Each different lake level, identified by beaches at a single characteristic elevation, represented a shift in position of the ice dam to the NE., different outlets at different elevations being used at different stages.

The sequence of glacial lakes that were impounded in the Lake Erie basin, in chronological order starting with the oldest, is as follows: Maumee I (800-ft. elevation), Maumee II (760-ft.), Maumee III (780-ft.), Arkona (710-690-ft.), Whittlesey (735-ft.), Wayne (660-ft.), Warren (680-665-ft.), Lundy (Grassmere beach at 640 ft., Dana beach at 620 ft., and Elkton beach at 615 ft.), and Erie (an early stage at 550? ft., early Algonquin stage at 535? ft., and modern Lake Erie at 573 ft.). Each change to a higher lake level represents a readvance of the ice and each lowering a retreat. The persistent fluctuations in this sequence of levels is thus a record of the oscillations of the retreating ice sheet. --Auth.

1-2721. Barton, Robert H. TRUTCH CREEK, B.C., AN EXCELLENT EXAMPLE OF STREAM PIRACY: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 1, p. 10-12, 21, map, 3 diags., Jan. 1959, 4 refs.

Trutch Creek, in northeastern British Columbia, captured the headwaters of Middle Fork Creek. This excellent example of stream piracy results from differing local base levels of erosion due partly to piedmont glaciation. The Trutch Creek piracy is part of a large system of stream capture involving imposition of a more recent drainage pattern upon an older structurally controlled pattern. Effects of stream piracy must be considered in geomorphic interpretations of geologic structures. --Auth.

1-2722. Scott, John, with the Killooleet Independent Speleological Society. CAVES IN VERMONT. A SPELUNKER'S GUIDE TO THEIR LOCATION AND LORE: 45 p., 15 illus., 5 maps, Hancock, Vermont, 1959, refs.

This directory of caves in Vermont is a report of the findings of 7 boys and girls of the Killooleet Independent Speleological Society. The Society originally intended to check all reports and make a complete survey of Vermont's caves. Such a survey was not feasible, and so a system of 2 types of listing was adopted. The caves located by latitude and longitude were confirmed by the Society in all but 3 instances. For these 3, reliable, recent reports were accepted. The "reported" caves are those which have not yet been located by the Society.

The confirmed caves (approximately 28) are listed and described alphabetically within each county and are followed by reported caves in each county. Geographic coordinates and elevations are given for each confirmed cave; also the name of the quadrangle in which the cave is located. A location map and an index of cave names are included. --L. M. Dane.

1-2723. Jarvis, N. L., Roscoe Ellis Jr., and O. W. Bidwell. A CHEMICAL AND MINERALOGICAL CHARACTERIZATION OF SELECTED BRUNIZEM, REDDISH PRAIRIE, GRUMUSOL, AND PLANOSOL SOILS DEVELOPED IN PRE-PLEISTOCENE MATERIALS: Soil Sci. Soc. America, Proc., v. 23, no. 3, p. 234-239, 3 tables, May-June 1959, 15 refs.; also pub. as: Kansas Agr. Expt. Sta., Contr. No. 596.

A study was made of the role parent materials have played in determining the physical and chemical properties of 4 soil series of southeastern Kansas. The soils of this region are dominantly Brunizems, but Planosols, Grumusols, and Reddish Prairie soils also occur. These soils have developed in residuum and colluvium of sandstone, limestone, and shales. The soil series studied were the Taloka, Newtonia, Bates, and Summit - each sampled and studied in duplicate. The physical and chemical properties investigated were clay mineral compostion, exchange capacity, total exchangeable cations, pH, percent organic matter, and particle size analysis.

Qualitative and semiquantitative estimations were made of the minerals occurring in the clay fractions of the soils and underlying parent materials. The predominant clay mineral in the Taloka, Newtonia, and Bates soils is montmorillonitic, whereas interstratified illitic and montmorillonitic clays are predominant in the Summit soils. Smaller amounts of quartz, illitic, kaolinitic, and vermiculite minerals are present in many of the clay fractions of the soils. The clay mineral contents of the developed soil profiles and their underlying parent materials were compared to determine the extent to which the clay minerals in the soil have been altered by weathering. --Auth.

1-2724. Summerson, C. H. PRE-GLACIAL RESIDUAL SOIL IN CENTRAL OHIO: Jour. Sed. Petrology, v. 29, no. 3, p. 430-435, 2 secs., table, Sept. 1959, 12 refs.

Study of a cherty, red, residual soil found in Madison County, Ohio, has resulted in the reconstruction of the chemical and environmental conditions necessary for its formation and the postulation of its probable age. The soil exists in solution pits and fractures in the Columbus limestone, overlain by Wisconsin drift. Studies of field relations and insoluble residues show the limestones to be the source rock. Soil and mineral analyses, considered on the basis of weathering necessary to alter the source minerals to minerals in the soil, indicate that the soil must have formed in a warm climate with heavy seasonal rainfall in an area of moderate relief. The relation of these conditions to the geologic history of the area suggests that the soil formation is of pre-Pleistocene age. --Auth.

1-2725. Whelpley, Don. WINDS, WAVES AND STORMS: Frontiers, v. 24, no. 1, p. 3-5, 33, 3 illus., Oct. 1959.

A popular article on types of ocean waves, the force of heavy storm surf, storm tides, and seismic waves.

1-2726. U.S. Office of Naval Research and National Academy of Sciences-National Research Council. SECOND COASTAL GEOGRAPHY CONFERENCE, HELD ON APRIL 6-9, 1959, AT THE COASTAL STUDIES INSTITUTE, LOUISIANA STATE UNIVER-

SITY: 472 p., illus., maps (1 in pocket), secs., graphs, tables, Washington, D.C., 1959, refs.

In the Second Coastal Geography Conference active participation was expanded to include some Europeans, and the subject matter was limited to the field of coastal morphology. Papers are listed below in the order of their appearance in these proceedings. Titles indicated in capital letters are separately abstracted.

McGill, John T. Coastal Classification Maps: a Review, p. 1-21, 35 refs. Includes map, Coastal Landforms of the World (fold. in pocket), scale 1: 25,000,000.

Bailey, Harry P. An Analysis of Coastal Climates with Particular Reference to Humid Midlatitudes, p. 23-55.

LeBlanc, Rufus J., and W. D. Hodgson. ORIGIN AND DEVELOPMENT OF THE TEXAS SHORELINE, p. 57-101.

Fisk, Harold N. PADRE ISLAND AND THE LAGUNA MADRE FLATS, COASTAL SOUTH TEXAS, p. 103-151.

Vann, John H. THE GEOMORPHOLOGY OF THE GUIANA COAST, p. 153-187.

Guilcher, André. COASTAL SAND RIDGES AND MARSHES AND THEIR CONTINENTAL ENVIRONMENT NEAR GRAND POPO AND OUIDA, DAHOMEY, p. 189-212.

Valentin, Hartmut. GEOMORPHOLOGICAL RECONNAISSANCE OF THE NORTH-WEST COAST OF CAPE YORK PENINSULA (NORTHERN AUSTRALIA), p. 213-231.

Straaten, L. M. J. U. van. LITTORAL AND SUBMARINE MORPHOLOGY OF THE RHÔNE DELTA, p. 233-264.

Evans, Graham. The Development of the Coastline of the Wash, England, p. 265-283.

Kuenen, Philip H. Dutch Post-War Coastal Studies, p. 285-300.

Schou, Axel. The Danish Moraine Archipelago as a Research Field for Coastal Morphology and Dynamics, p. 301-315.

Steers, J. A. Archaeology and Physiography in Coastal Studies, p. 317-340.

McIntire, William G. METHODS OF CORRELATING CULTURAL REMAINS WITH STAGES OF COASTAL DEVELOPMENT, p. 341-359.

Field Excursion Itineraries.

Russell, Richard J. Background for Field Excursions, p. 363-383.

Morgan, James P. Mississippi Deltaic Plain Flight, p. 385-390.

Russell, Richard J. Alluvial Morphology Field Trip, p. 391-407.

Morgan, James P. Coastal Marsh and Chenier Field Trip, p. 409-415.

Kniffen, Fred B., William G. McIntire, and Lewis G. Nichols. Southwestern Louisiana Field Trip. Land and Man in Chenier, Louisiana, p. 417-422.

Bibliographical Data

Morgan, James P. Activities and Research Results of the Coastal Studies Institute, p. 425-440.

Appendix: Abstracts of Technical Reports of the Coastal Studies Institute.

Russell, Richard J., and James P. Morgan. Photo-Interpretation Keys of Selected Coastal Marshland Features, p. 441.

Morgan, James P., Jack R. Van Lopik, and Lewis G. Nichols. Occurrence and Development of Mudflats Along the Western Louisiana Coast, p. 442-443.

Russell, Richard J. Alluvial Morphology of Anatolian Rivers, p. 444-445.

Morgan, James P., and Staff. Trafficability and Navigability of the Louisiana Coastal Marshlands, p. 446.

McIntire, William G. Correlation of Prehistoric Settlements and Delta Development, p. 447-450.

Treadwell, Robert C. Sedimentology and Ecology of Southeast Coastal Louisiana, p. 451-455.

Van Lopik, Jack R. Recent Geology and Geomorphic History of Central Coastal Louisiana, p. 456-458.

Dunbar, Gary S. Geographical History of the Carolina Banks, p. 459-460.

Haag, William G. The Archeology of Coastal North Carolina, p. 461-463.

Brown, Clair A. Botanical Reconnaissance of the Outer Banks of North Carolina, p. 464-465.

Morgan, James P., and William G. McIntire. Quaternary Geology of the Bengal Basin, p. 466-468.

Morgan, James P., Lewis G. Nichols, and Martin Wright. Morphological Effects of Hurricane Audrey on the Louisiana Coast, p. 469-470.

Russell, Richard J. Preliminary Notes on Caribbean Beach Rock, p. 471-472.

1-2727. LeBlanc, Rufus J., and W.D. Hodgson. ORIGIN AND DEVELOPMENT OF THE TEXAS SHORELINE (In: U.S. Office of Naval Research and National Academy of Sciences-National Research Council. Second Coastal Geography Conference...: p. 57-101, 8 illus., 14 maps, sec., Washington, D.C., 1959) 66 refs.

The shoreline of Texas forms the boundary between the northwestern Gulf of Mexico and the western Gulf coastal plain for a distance of about 375 mi. between Mexico and Louisiana. The shoreline trends in a north-northeasterly direction and generally parallels the regional trend of the coastal plain and the outer edge of the continental shelf. The seaward slope of that portion of the coastal plain which lies below 300 ft. elevation is about the same as the slope of the inner continental shelf which is less than 300 ft. deep. This slope varies from about 6 ft. per mi. S. of Corpus Christi to about 2 1/2 ft. per mi. E. of Galveston, Texas.

The coastal features of Texas can be divided into 4 main groups on the basis of their general characteristics and origin. These are 1) alluvial valleys and deltaic plains, 2) estuaries, 3) barrier islands, and 4) lagoons.

The Gulf coastal plain in Texas is drained mainly by 9 rivers and their tributaries. Each stream of coastal Texas flows within an alluvial valley of Recent age which merges with a deltaic plain near the coast. The size of the alluvial valley and deltaic plain for any one stream is proportional to the size and silt load of that stream. Large streams, such as the Rio Grande and the Brazos River, have wide alluvial

valleys and broad deltaic plains and empty directly into the Gulf of Mexico. Smaller streams, such as the Nueces and San Jacinto rivers, flow in comparatively narrow valleys and empty into shallow bays or estuaries which lie behind barrier islands. These estuaries, such as Baffin, Corpus Christi, San Antonio, and Galveston bays, are elongated perpendicular to the coast. The lagoonal type of bay lies directly behind the barrier island and is elongated parallel to the coast, or normal to the estuary type of bay. Examples of this type are Laguna Madre, Aransas, Matagorda, West, and East bays. The barrier islands of Texas range in length from about 15 mi. to over 110 mi. and rise as much as 50 ft. above sea level. One of the characteristic features of these barrier islands is a series of abandoned beach ridges which are aligned parallel to the present seaward edge of the islands.

Thus, the shoreline of Texas is actually a compound feature. It consists of a Gulf shoreline and a bay shoreline. The Gulf shoreline is the seaward edge of the barrier islands and deltaic plains and the bay shoreline lies at the edge of the mainland and behind the barrier islands. The Gulf shoreline is generally very regular, arcuate, and characterized by well-developed sand beaches. In contrast, the bay shoreline is quite irregular and generally devoid of sand beaches. In many places the bay shoreline is associated with low-lying Recent marshes; low bluffs characterize the bay shoreline whereever wave action is eroding Pleistocene terrace deposits.

Geological events associated with the late Quaternary have controlled the origin and development of the Texas shoreline. Some features of the shoreline are of late Pleistocene age while others are definitely related to the Recent epoch. During the last Pleistocene glacial stage when sea level was lowered approximately 450 ft., the coastal Texas streams deeply entrenched their valleys and the Gulf shoreline was probably 50 to 140 mi. seaward of the present shoreline. With melting of the late Pleistocene glaciers and the accompanying rise in sea level, Texas streams alluviated their entrenched valleys. Sedimentation in these valleys did not keep pace with rising sea level and consequently the lower portions of the entrenched valleys were drowned to form a series of estuaries. The bay shoreline of Texas originated during this stage. During the standing sea level stage, which began about 5,000 years ago, the large Texas rivers, such as the Rio Grande, Brazos, and Colorado filled their former estuaries and constructed broad deltaic plains which protrude into the Gulf. The other smaller Texas rivers which carry lesser quantities of sediments are still in the process of filling their drowned valleys or estuaries. A series of barrier islands were formed along the coast between the Rio Grande and Colorado-Brazos deltaic plain and E. of the Colorado-Brazos deltaic plain, giving rise to the Gulf shoreline along these segments of the coast. The abandoned beach ridges and intervening low swales and mud flats, which are well preserved on these barrier islands, clearly demonstrate the seaward growth of the islands during the standing sea level stage.

Although most of the Gulf shoreline of Texas has regressed seaward during the past few thousand years, there are a few notable examples of local marine transgressions. Three of the examples are discussed.

In summary, it appears that a combination of factors, including fluctuations in sea level associated with the last Pleistocene glacial stage, the seaward slope of the late Pleistocene coastal plain, the amount and location of sediments contributed to the coastal region by Texas streams, longshore currents and waves in the Gulf of Mexico, and variations in climatic conditions from E. Texas southward to the Rio Grande have led to the origin and development of the modern shoreline of Texas. --Auth.

1-2728. Fisk, Harold N. PADRE ISLAND AND THE LAGUNA MADRE FLATS, COASTAL SOUTH TEXAS (In: U.S. Office of Naval Research and National Academy of Sciences-National Research Council. Second Coastal Geography Conference...: p. 103-151, 31 illus., 4 maps, 2 secs., 2 tables, Washington, D.C., 1959) 13 refs.

Padre Island and the Laguna Madre depression began to form slightly more than 5,000 years ago when the sea had risen to within 20 to 30 ft. of its present level. The gulf shoreline then was slightly inland but very close to the modern shoreline. The final rise of sea level appears to have been very rapid, and the barrier-island chain was initiated during this rise as a series of offshore islands. At the time sea level reached its present stand, 4,500 to 5,000 years ago, the lagoon was deeper than at any time in its history. The offshore islands were integrated to form Padre Island about 4,000 years ago, and at that time the lagoon became isolated from the gulf. Filling of the lagoonal depression progressed rapidly, and salinity of lagoonal waters increased, restricting the fauna. The same dwarfed mollusks which characterize the present hypersaline lagoon were dominant elements in the fauna 3,700 years ago.

The abnormally rapid sedimentation leading to the development of the Laguna Madre flats was determined in part by the location of the area at the westernmost position of the barrier arc. At this location large amounts of sand have long been available for translation to the lagoon by SE. winds and by storm-driven waters. The alignment of the southern Laguna Madre permits the prevailing SE. winds to generate currents and to drift sands northward. Rapid sedimentation of the flats area was also determined in part by the presence of the erosional reentrant sculptured in the mainland margin during the low stand of the late Quaternary sea. This reentrant was flooded when the gulf reached its present level, creating a locally broad embayment which tended to dissipate wave and current energies, causing deposition of sand particles.

Padre Island has been greatly enlarged during the last 4,000 years. Development of the alluvial apron on the lagoonward side has widened the island westward, and longshore currents and wave action have extended the island seaward. Stages in the seaward growth are marked by the sequence of beach ridges underlying sand dunes of the island.

Computations based on the rate of sedimentation in the flats indicate that the final closing of the lagoon took place approximately 150 years ago when the Sand Bulge had grown nearly to Mesquite Rincon. Both surface and subsurface waters then became highly saline, and mat-forming blue-green algae flourished on the mud flats and assisted in the trapping of the clays. Gypsum was deposited by subsurface waters and gave rise to thin layers of finely granular crystals interspersed with the laminated algal-rich clays and to sand-gypsum crystals in the lagoonal sands below the water table. As sedimentation continued, the eolian topography of the mainland became alluvially drowned and served to divide the western area of the flats into distinct basins, which acted as evaporating pans, further increasing the salinity of surface waters. The action of wind-driven waters, combined with the west-

ward drift of sands from Padre Island, has shaped depositional features on the flats surface into well-defined elements that have retained their shape while the area has been built above sea level. --Auth. summ. and concl.

1-2729. Vann, John H. THE GEOMORPHOLOGY OF THE GUIANA COAST (In: U.S. Office of Naval Research and National Academy of Sciences-National Research Council. Second Coastal Geography Conference...: p. 153-187, 16 illus., 7 maps, 3 secs., Washington, D.C., 1959) 5 refs.

The lower coastal plain of the Guianas from the Waini River mouth in the Northwest District in British Guiana to Irocoubo Creek in French Guiana is primarily an accretional coast that has been built up by the deposition of mudflats that become fixed by vegetation and remain as permanent features. The deposition of mud is interrupted at times by erosional periods during which sand beaches are formed by wave action and are cut off from the sea by later periods of mud accretion. The action of wave erosional processes and accretional current processes along the present shoreline indicate that the periods of erosion and accretion are not clearly separated from each other. If processes along the present shoreline are indicative of past conditions, it appears that sand ridge formation and mudflat formation proceed simultaneously, with one predominating over the other during certain periods of time... Most of the sand ridges are not continuous features but are broken here and there by small gaps. During times when erosion or deposition gains an upper hand over most of the shoreline, breaks are caused by slight changes in sediment supply and wave and current intensity. It does not appear than any major change in the weather pattern or shift in ocean currents is required. A failure of the short rainy season, or a few years during which it fails to develop fully, perhaps because of a failure of the trades to become well established, would be sufficient cause to upset a period of erosion and initiate deposition at the shoreline... The speed with which morphologic changes are effected along the present shoreline makes the Guiana Coast one of the most interesting sedimentary localities in the world. Some mud banks in Surinam E. of river mouths have grown westward as much as 3.5 km. in 70 years, and in French Guiana a growth of 100 to 150 m. a year E. of the Kaw and Sinnamary mouths and 2,000 m. in the period 1938-1948 E. of the Mana mouth [has been recorded]... It is not unusual for a mud bank to accrete to a square mile in area and move on westward before it can be fixed by vegetation. Such has occurred E. of the mouths of the smaller creeks at various places in Surinam and British Guiana...

The age of the entire lower coastal plain appears to be Recent, based on a study of the shell fauna along present beaches, in the stranded sand ridges, and from deep (1,600 ft.) and shallow borings (30 to 60 ft.). According to the Louisiana State University Paleontological Museum and the Smithsonian Museum, Washington, D.C., none of the shells collected by the writer in the lower coastal plain are older than the Recent. The lower coastal plain, therefore, probably represents a sequence of shoreline development restricted to the period of sea level adjustment following the disappearance of the last ice sheet of the Pleistocene. The loosely consolidated nature of lower coastal plain sediments and the uniformity of sediments throughout the lower plain tends to confirm this conclusion. --From auth. concl.

1-2730. Guilcher, André. COASTAL SAND RIDGES AND MARSHES AND THEIR CONTINENTAL ENVIRONMENT NEAR GRAND POPO AND OUIDAH, DAHOMEY (In: U.S. Office of Naval Research and National Academy of Sciences-National Research Council. Second Coastal Geography Conference...: p. 189-212, 2 maps, diag., 8 graphs, table, Washington, D.C., 1959) 27 refs.

Besides general features which are common to the coastal swamps, marshes, and beach ridges of Nigeria, Dahomey, Togo, Ghana, and Ivory Coast, the coastal district of SW. Dahomey offers some particularities. A curious point is the scarcity of the mangroves. The pattern of beach ridges and barriers is less regular than in W. Nigeria and in Togo, probably as a consequence of the shifting course of the Mono which brought alterations and destructions in the old bars. Lake Ahémé is certainly an old estuary, separated from the sea by marshes which receive much more water from the Mono than the Couffo. If the sediments had been principally supplied by the Couffo, they would have been deposited at first in the lake, which would have been filled up. In fact, this sequence of sedimentation exists on a comparatively small scale at the upper end of the lake, but the most interesting feature of this area, an estuary barred by a wide stretch of marshes and successive sand ridges although it is not itself completely filled up, results from the existence and the dependable discharge of the Mono. As the water of the Mono flows sometimes into the lake, it would be useful to carry out measurements of the turbidity of this river during the floods, in order to get an idea of what can be deposited in the lake. It is necessary to have in mind that probably the larger part of the suspended sediments does not remain in the marshes nor in the lake; it is carried out to the sea, as shown by the large masses of turbid waters pouring out through the outlet in Sept. and Oct. What becomes of these fine sediments in the Bight of Benin remains a matter of speculation so far, as the continental shelf and slope have not been studied. --Auth.

1-2731. Valentin, Hartmut. GEOMORPHOLOGICAL RECONNAISSANCE OF THE NORTH-WEST COAST OF CAPE YORK PENINSULA (NORTHERN AUSTRALIA) (In: U.S. Office of Naval Research and National Academy of Sciences-National Research Council. Second Coastal Geography Conference...: p. 213-231, Washington, D.C., 1959) 11 refs.

As a partial and preliminary result of a geomorphological survey of the whole W. coast of Cape York Peninsula, the present paper offers a first reconnaissance report on the NW. coast from the Jardine River (10°55'S.) to the Archer Bay (13°20'S.). The hinterland is here a plateau of Cretaceous sandstone covered by Tertiary laterite. This plateau was tilted westwards and, mainly in the southern portion, also warped slightly along ESE. -WNW. axes. The lower parts of the river valleys cut into the plateau were drowned by an early Recent rise of sea level. During the maximum submergence in mid-Recent times the sea stood at an old shoreline which can be traced along most of the coast. A small late Recent fall of sea level appears to have interfered here with a N. -S. tilting of the coast; in the N., the old shore features emerged to about 25 ft. above present sea level, drowned valleys were silted up, and the coast was prograded for up to 12 mi. by beach ridges behind which mangrove swamps, salt flats, and marshes developed. In the S., however, the emergence was very small; the valleys are still drowned, and the

cliffs of the Pera Head Peninsula are still being attacked by the sea. Contrary to common belief, there are practically no mangroves along the outer shoreline of the NW. coast. --Auth.

1-2732. Straaten, L.M.J.U. van. LITTORAL AND SUBMARINE MORPHOLOGY OF THE RHÔNE DELTA (In: U.S. Office of Naval Research and National Academy of Sciences-National Research Council. Second Coastal Geography Conference...: p. 233-264, 5 maps, 4 secs., 3 profiles, 2 graphs, log, Washington, D.C., 1959) 7 refs.

A relief of closely spaced gullies was found on the steepest part of the delta front S. of the present mouth of the Grand Rhône. The gullies are explained as the result of slow turbidity currents. A few of them may also be related to phenomena of subaqueous sliding of sediments. It is concluded that the slope of this part of the delta front is steepening all the time and that sliding will become of regular occurrence in the near future.

A series of cores taken in this area shows the great lateral continuity of the stratification. It is supposed that the coarse-grained layers have been deposited during river floods. The rate of sedimentation of this foreset material is very high, probably some 35 cm. per year at a depth of 50 m.

The steep slope of the Grand Rhône foreset beds seems to be a new phenomenon in the history of the Rhône delta. Delta fronts that were actively prograding in former stages were usually more gently inclined. A very important factor, determining the angle of those slopes, is the initial profile of the sea floor.

On both sides of the present mouth of the Grand Rhône there are shallow, submarine platforms. These are due to truncation by wave erosion of old cones of foreset deposits. It is likely that wave action caused transport of the sand from the eroded tops of these beds towards the shore, where it was carried off laterally by beach drifting.

On the western part of the shelf a relief of terraces, ridges, and troughs is found. The ridges are in all probability "drowned" bars, originally formed in very shallow water close to the shore, during the last stages of the Pleistocene. One of the terraces is composed of old foreset beds, deposited in the near vicinity of a river mouth. The front slope of this terrace may represent the original slope of the delta front, covered only by a thin veneer of younger, normal marine sediments. The upper surface may be a platform produced by wave erosion which set in after the distributary, supplying sediment to this part of the delta front, became abandoned.

The eastern part of the shelf area shows no such old relief features, except farther offshore, in depths of 100 m. and more. They have been covered by a blanket of recent deposits, formed during the later part of the Holocene when sea level stood approximately at its present position. In this most recent period the coast of the delta has begun to advance again, after its long continued northward retreat during the preceding stage of rapidly rising sea level. --Auth.

1-2733. McIntire, William G. METHODS OF CORRELATING CULTURAL REMAINS WITH STAGES OF COASTAL DEVELOPMENT (In: U.S. Office of Naval Research and National Academy of Sciences-National Research Council. Second Coastal Geography Conference...: p. 341-359, 4 illus., 3 maps, chart, sec., Washington, D.C., 1959) 9 refs.

During the past 2,000 years that man has lived in coastal Louisiana his material culture has gradually changed from one form to another, and the measurement of these changes delineates time periods. The cultural remains found primarily in mounds and middens are keys to processes and sequences of coastal development. As the master stream and its distributaries shifted from one course to another, new land was formed and because of lack of sedimentation the old land gradually deteriorated. Whenever lack of human requirements forced man to leave his old homesites he moved to areas where they were available. Concentrations of initial occupation sites of a particular time period in one area and the absence of them in another shows regions that were habitable during certain stages of delta development.

Although sedimentation, water salinity, subsidence, deterioration, and stages of coastal growth and retreat are all indicated by cultural remains, one of the most important relationships is between initial occupation sites and stages of chenier and stream development. When initial occupation sites are mapped for an entire area many interrelated correlations between streams, cheniers, and beaches and the sites based upon them are readily apparent.

This method produces clues for interpreting the physical area as a whole, as well as providing more detailed information about segments of a given area. Total mapping of initial occupation sites presents a pattern that is subject to field check and is useful in setting the stage for additional detailed geological research. --Auth. summ.

3. STRUCTURAL GEOLOGY

See also: Areal and Regional Geology 1-2682, 1-2696, 1-2697, 1-2698, 1-2708; Stratigraphy 1-2766; Paleontology 1-2785; Geophysics 1-2797, 1-2809, 1-2810, 1-2815; Mineral Deposits 1-2891, 1-2893; Fuels 1-2913.

1-2734. Haites, T. Binnert. AVONLEA AND ITS SIGNIFICANCE: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 8, p. 167-176, map, 4 diags., Aug. 1959, 28 refs.

Reexamination of the controversial Avonlea structure SW. of Regina, Saskatchewan, results in support of the fault hypothesis of previous students. The nature of these faults is discussed, particularly with reference to the theory of solution-collapse and the geological implications of the Regina earthquake. --Auth.

1-2735. de Wit, Rein. DIAPIRIC STRUCTURE NEAR ALEXANDRA FALLS, HAY RIVER, N.W.T.: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 3, p. 48-50, map, March 1959, 5 refs.

A small structure resembling a diapiric intrusion was observed in the canyon of the Hay River, Mackenzie District, approximately 1/4 mi. NE. of Alexandra Falls. The structure is described and 3 possible explanations of its origin are discussed: 1) penecontemporaneous slumping (prior to complete diagenesis), 2) piercement of the shaly limestone into the overlying beds due to overloading, 3) filling of a preexisting cave. The first 2 explanations are ruled out, and it is concluded that the structure must represent penetration of shale and shaly limestone into a cavity in

the limestone. The most likely mechanisms for forcing the shaly beds into the cave appear to be frost action or overloading. --A. C. Sangree.

1-2736. Dietz, Robert S. SHATTER CONES IN CRYPTOEXPLOSION STRUCTURES (METEORITE IMPACT?): Jour. Geology, v. 67, no. 5, p. 496-505, 18 illus., Sept. 1959, 34 refs.

Shatter cones (striated percussion fracture cones), apparently formed by explosive percussion, are known only from 4 cryptoexplosion (i.e., "cryptovolcanic") structures, viz., Steinheim basin [Germany], Wells Creek basin [Tennessee], the Kentland deformation [Indiana], and the Crooked Creek structure [Missouri]. The nature of these shatter cones and their orientation at these 4 localities are described. It is concluded that the shatter cones may be a useful criterion for establishing that cryptoexplosion structures of the damped-wave type are probably formed by the hypervelocity and explosive impact of large meteorites. In any event, it is hoped that this paper will draw attention to these unusual structures so that geologists will be on the lookout for them in small, highly deformed, circular structures. --Auth.

1-2737. Nininger, H.H. ANOTHER METEORITE CRATER STUDIED: Science, v. 130, no. 3384, p. 1251-1252, Nov. 6, 1959.

Little Dalgaranga crater in Western Australia has previously been described as being 225 ft. in diameter and 15 ft. deep. Its true dimensions are 70 ft. in diameter and 10 1/2 ft. deep. --M. Russell.

1-2738. Wilson, J. Tuzo. GEOPHYSICS AND CONTINENTAL GROWTH: Am. Scientist, v. 47, no. 1, p. 1-24, 4 maps, 2 secs., 3 diags., table, March 1959, 4 refs.

Modern theory on the internal structure of the earth and the growth of continents can draw on the following kinds of evidence: 1) Topographic shape: lands; bathymetric shape: ocean floors. 2) Geology of the continents and of the ocean basins; gross similarities and repetitions are of greater value than secondary differences. 3) Seismic evidence of the thickness and distribution of subsurface layers and structures. 4) Seismic evidence of the distribution and direction of movement of earthquakes which give direct evidence of internal movements. 5) Absolute age determinations which provide a time scale. 6) Irregularities in the earth's magnetic and gravity fields which provide evidence of the internal nature of the earth. 7) Studies of flow of heat from the earth. 8) Examination of the rate of emission of matter from inside the earth through volcanoes and of the rates of other geological processes.

The available evidence supports the following conclusions. Continents grow in a series of zones, each representing the former position of part of the system of active mountains where a continental fracture system once spewed out andesitic lavas. The present rate of emission of lava is of the right order of magnitude to have produced all the crust during geological time, and this would have produced more contraction than any reasonable amount of cooling of the earth. Contraction would lead to fracturing of a kind likely to lead to the principle observed feature of past and present mountain systems. Continental drift is without a cause or a physical theory. Convection currents may exist within the mantle, but this is hypothesis incapable of explaining many of the properties of existing mountains. Polar wandering can have occurred without affecting the arguments for contraction.

The ocean basins are the original crust, only thinly covered with basalt. The mid-ocean and continental fracture systems are the breaks which allow the earth to shrink. Conservation of energy tends to keep them as far apart as possible. The mid-ocean ridges and the continents are made of the material spewed out along these breaks during the earth's history. The mid-ocean system has not migrated much, but the more active continental system has swung about from one side of the continents to another resulting in zoned complexes of crustal scar tissue. The earth has given birth to its own oceans, atmosphere, islands, and continents, and is continuing to generate them at its usual rate. --From auth. introd. and concl.

1-2739. Latynina, L.A. ON THE EXISTENCE OF CONVECTION CURRENTS IN THE MANTLE OF THE EARTH: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 219-223, graph, March 1958, pub. July 1959, 14 refs.

A critical analysis is presented of the reality of Vening Meinsz' theory of convection currents in the mantle. The physical conditions required to generate these currents are analyzed; it is found that the necessary assumptions are reasonable but that the reality of convection cannot be proven, primarily because the numerical values of many physical factors entering into the equations are not even approximately known. It is concluded that although present knowledge of the physics of the earth does not permit a positive solution of the question, the existence of these currents is possible because the required thermodynamic conditions (for instance, the great difference in temperature between the ocean bottom and land masses at the same depth) are without doubt fulfilled. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-229).

1-2740. Charlesworth, H.A.K. SOME OBSERVATIONS ON THE STRUCTURAL DEVELOPMENT OF THE ROCKY MOUNTAINS OF CANADA: Edmonton Geol. Soc., Quart., v. 3, no. 1, p. 2-7, 3 figs., March 1959, 18 refs.

The Canadian Rocky Mountains consist essentially of deformed, unaltered, or slightly metamorphosed sedimentary rocks, resting on an undeformed basement complex assumed to belong to an extension of the Churchill province of the Canadian Shield. By the time they underwent orogeny in the lower Tertiary, the area to the W., the western Cordillera of British Columbia, was already mountainous.

The Rocky Mountain orogeny took place in response to a southwesterly movement of the Canadian Shield under the stable block of the western Cordillera. During the orogeny, the sedimentary cover in the Rocky Mountain area was stripped from its underlying basement. As the orogeny gathered strength, the deformational front advanced from SW. to NE., only to retreat SW. during the waning stages.

Thrusting and folding developed as a result of that component of the movement of the Shield normal to the boundary between the western Cordillera and the wedge of sedimentary rock comprising the Rocky Mountain ensialic geosyncline. The tangential component gave rise to wrench faulting in the western Rocky Mountains. Normal faulting may have taken

place contemporaneously with Miocene epeirogenic uplift. --Auth.

1-2741. Sawatzky, H.B., R.G. Agarwal, and W. Wilson. STRUCTURE TEST HOLES CONFIRM POST-PALEOZOIC RELIEF AS INDICATED BY THE SEISMOGRAPH IN THE AVONLEA AREA, SASKATCHEWAN: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 4, p. 82-90, 92, 4 maps, 6 secs., 5 diags., Apr. 1959, 7 refs.

The correlation between seismic and structure test hole data is exhibited in the Avonlea area of Saskatchewan. The results appear to indicate that previously inferred faults are nonexistent. In addition, the primary causes of post-Paleozoic structure are discussed and attributed to salt removal with subsequent collapse of the overlying beds. --Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Geologic Maps 1-2679; Areal and Regional Geology 1-2684, 1-2699 through 1-2706; Paleontology 1-2770, 1-2772, 1-2773, 1-2783, 1-2784, 1-2789; Geophysics 1-2803; Sedimentary Petrology 1-2863 through 1-2867, 1-2873, 1-2874.

1-2742. Dryden, Lincoln and Clarissa Dryden. HEAVY MINERALS FROM THE NORTH CAROLINA COASTAL PLAIN: Pennsylvania Acad. Sci., Proc., p. 185-194, fig., 4 tables, 1959, 8 refs.

The principal subject of this paper is the comparison of heavy-mineral suites of outcrop samples with those from down dip, in deep wells. Most of the samples described come from the Coastal Plain of North Carolina.

In the heavy-mineral data given, the authors have disregarded opaque minerals, micas, glauconite, and certain other (probably authigenic) minerals which seem to have no bearing on the immediate problem. --Auth.

1-2743. Winder, C.G. CONTACTS OF SEDIMENTARY FORMATIONS: A RESUME: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 7, p. 149-156, 2 illus., July 1959, 16 refs.

A contact is the boundary or limiting surface of a formation. Although this feature, common to adjacent rock units, is used to establish stratigraphic, sedimentational, and structural relationships, accurate and complete descriptions are often neglected or omitted. The contact may be conformable or unconformable; the relationship may not be consistent over the area of occurrence. The unconformable relationship is interpreted as representing a prolonged period of erosion; the conformable contact would seem to be an environmental change, usually within the same realm of deposition. More information on contacts should be recorded. --Auth.

1-2744. Gussow, William Carruthers, and C. Warren Hunt. AGE OF THE ICE RIVER COMPLEX, YOHO NATIONAL PARK, BRITISH COLUMBIA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 3, p. 62, March 1959, ref.

On Aug. 1, (1958?) the authors discovered in the Ice River vicinity, S. of Field, that the contact between the Upper Cambrian Ottertail limestone and the syenite is a sedimentary one, implying a Precambrian age for the complex.

1-2745. Frezon, Sherwood E., and Ernest E. Glick. PRE-ATOKA ROCKS OF NORTHERN ARKANSAS: U.S. Geol. Survey, Prof. Paper 314-H, p. 171-189, 13 maps (12 in pocket), table, 1959, 25 refs.

The part of Arkansas discussed in this report lies N. of the Ouachita Mountains and W. of the Gulf Coastal Plain and includes parts of the Ozark region and the Arkansas Valley. Pre-Atoka rocks of Ordovician, Silurian, Devonian, Mississippian, and early Pennsylvanian age crop out in the Ozark region, dip southward under a cover of thick Atoka and younger Pennsylvanian rocks in the Arkansas Valley, and reappear at the surface in the Ouachita Mountain region. Outcrops and wells provide data on the pre-Atoka rocks in the Ozark region and the northern part of the Arkansas Valley; few wells have been drilled in the southern part of the Arkansas Valley and correlations of pre-Atoka rocks between the northern part of the Arkansas Valley and the Ouachita Mountain region cannot be made directly.

The regional structure of pre-Atoka rocks of the Ozark region and the northern part of the Arkansas Valley is reflected by the regional structure of the base of the Boone formation. The regional dip of the base of the Boone formation increases gradually from 10 ft. per mi. to 200 ft. per mi. southward across the Ozark region, and steepens to as much as 500 ft. per mi. along the northern limb of the Arkansas Valley geosyncline.

Thirty-two pre-Atoka formations, ranging from Cambrian to early Pennsylvanian in age, crop out in northern Arkansas and southern Missouri but subsurface data are sufficient to determine the regional thickness and lithofacies of only the Everton formation (Ordovician) and younger rocks. The Everton formation and St. Peter sandstone (Ordovician) combined, a predominantly dolomite and sandstone unit, increases in thickness to the S. and E. and contains a greater percentage of sandstone to the NW. and NE. The series of limestone beds and the overlying shale, which makes up the post-St. Peter rocks of Ordovician age, increases in thickness to the SE. but the individual formations of the unit do not change in lithology in the area. Silurian rocks and the Penters chert (Devonian) increase in thickness to the S. in the western two-thirds of the area and decrease in thickness to a truncated edge in the southeastern part of the area. The Chattanooga shale increases in thickness southward into the Arkansas Valley and westward in Benton, Washington, and Crawford counties in the northwestern part of the area. Mississippian rocks, which are composed of limestone, chert, and shale in the N. and W., thicken slightly southward in the western half of the area and thicken rapidly to the SE. in the eastern half of the area, where they are represented by more than 2,500 ft. of black shale. The thickness of the chert and limestone beds of the Boone formation (Mississippian) decreases to the W. and S. from the type area in N.-central Arkansas, and southeastward the formation grades into black shale. The thickness distribution of Moorefield-to-Pitkin rocks (Mississippian) is similar to that of the total thickness of Mississippian rocks.

The thickness of rocks of Morrow age increases

to the S. and SE. The percentage of sandstone in the interval between the Pitkin limestone (or the Fayetteville shale) and the Prairie Grove member of the Hale formation (or its apparent equivalent S. and E. of Washington County) increases to the NE. and NW. from the S.-central part of the area. The percentage of limestone in the Prairie Grove member of the Hale formation and the Bloyd shale of Washington County and of their apparent equivalents S. and E. of that area decreases to the E. and SE.

The pre-Atoka Paleozoic rocks of northern Arkansas are dominantly marine. Pre-Chattanooga rocks, which are dominantly marine carbonate sediments, were deposited in relatively shallow, extensive seas. Until the end of St. Peter time, sand was swept intermittently into the area and deposited, but after St. Peter time, Ordovician, Silurian, and Devonian sediments were deposited in seas relatively isolated from sources of coarse clastic sediments. Numerous periods of uplift and erosion interrupted deposition in pre-Chattanooga time and the distribution of the pre-Chattanooga rocks indicates that considerable areal truncation preceded the deposition of both the Penters chert and the Chattanooga shale. Mississippian sandstones, shales, limestones and cherts were deposited on a shelf area in northern and western Arkansas and in a deeper basin to the S. and E. of the shelf. The dominantly clastic pre-Atoka sediments of Pennsylvanian age were deposited in shallow seas. The area was uplifted and eroded before the deposition of the Atkoa formation.

No commercial quantities of oil have been found in northern Arkansas, but commercial quantities of gas have been produced from 5 zones in the pre-Atoka rocks of the area, as well as from several zones in Atoka rocks. It is probable that additional gas will be discovered in pre-Atoka rocks in northern Arkansas. Source beds, reservoir rocks, and geological structures present in the area indicate that oil may be present in small pools in the area. --Auth.

1-2746. Boler, Milton E. PRE-DESMOINESIAN ISOPACH AND PALEOGEOLOGIC STUDY OF NORTHWESTERN OKLAHOMA: Shale Shaker, v. 9, no. 10, p. 6-18, 17 maps, chart, June 1959, 31 refs.

This study includes approximately 12,375 sq. mi. in NW. Oklahoma, bounded on the N. by Kansas, on the W. by Texas (excluding the 2 westerly panhandle counties of Oklahoma), on the S. by T. 12N., and on the E. by R. 9W. It deals with the pre-Des Moinesian rocks of the NW. flank of the Anadarko basin. Descriptions and the history of nomenclature of the formations from Arbuckle (Ordovician) to the Atoka series (Pennsylvanian) are detailed.

Isopachous studies of the several systems and/or groups have indicated the following conclusions. The Simpson group thins to the N. and NW. The Viola-Fernvale thins generally to the N. and E. from 508 ft. in Harper County to 48 ft. in Alfalfa County. The Sylvan shale originally covered the entire area but has been removed from the N. and NW. portions by later unconformities. The maximum section encountered, measures 126 ft. in Dewey County. The Hunton group parallels the Sylvan in that it also has been removed by erosion from the N. and NW. portion of the area. It attains a maximum thickness of 551 ft. in Dewey County. The Woodford shale attains a maximum thickness of 170 ft. in Alfalfa County but has been removed entirely in Beaver County. The Mississippian attains a maximum thickness of 2,818 ft. in Ellis County and a minimum of 371 ft. in Alfalfa County. The thinning is due to erosion by the basal Pennsylvanian unconformity. The Springer is present only in the southern part of the area with a maximum thickness penetrated of 343 ft. in Custer County. The Morrowan thins from 1,473 ft. in Ellis County to 0 ft. in the N. and northeastern part of the area. The Atoka thins to the NE. with a maximum thickness of 1,057 ft. Paleogeologic maps on the base of the Woodford, and on the base of the Des Moinesian series show the limits of the various underlying formations.

Epeirogenic movements were mild throughout the early Paleozoic, with the northern shelf of the Anadarko basin oscillating and causing the various formations to have an offlap and overlap relationship as well as removing entirely some from the shelf area. The southern part of the area had a normal geosynclinal downwarping and accumulation of sediments. The major orogenic movements are post-Hunton and pre-Woodford, post-Mississippian and pre-Des Moinesian with the maximum movement occurring at the end of Morrowan time. During late Pennsylvanian time the Arbuckle mountains to the S. were formed. Gentle folding in post-Permian and pre-Cretaceous time produced the present Anadarko syncline. --C. E. Branham.

1-2747. Nelson, Samuel J. GUIDE FOSSILS OF THE RED RIVER AND STONY MOUNTAIN EQUIVALENTS (ORDOVICIAN): Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 3, p. 51-61, illus., diags. on 4 pls., chart, March 1959, ref.

Twenty-three easily recognizable fossil genera and species from the Ordovician Red River and Stony Mountain equivalents [in western Canada] are illustrated. Methods are described by which a geologist in the field can use these fossils to distinguish Red River and Stony Mountain equivalents from Silurian and from each other. --Auth.

1-2748. Howe, Herbert J. MONTOYA GROUP STRATIGRAPHY (ORDOVICIAN) OF TRANS-PECOS TEXAS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 10, p. 2285-2332, 17 illus., 2 maps, chart, 11 secs., graph, 5 tables, Oct. 1959, 52 refs.

Sections measured in the Franklin and Organ mountains show the Lower Ordovician El Paso formation to have been progressively truncated toward the N., and to be overlain disconformably by the Middle(?) and Upper Ordovician Montoya group.

This group from the base up is divided into: the Cable Canyon sandstone (coarse, orthoquartzitic) replaced in the Baylor Mountains by a St. Peter sandstone equivalent; the Upham formation (dolomite or limestone) containing a Red River fauna, which is probably upper Trenton or possibly lower Cincinnatian in age; the Aleman formation (also dolomite or limestone with much chert, in bands or nodules) with a Maquoketa fauna, notably the coral Palaeophyllum thomi, which crops out in a marker bed for 140 mi.; and the Cutter formation (noncherty dolomite) with a late Ordovician fauna near its base. --Auth.

1-2749. Andrichuk, John M. ORDOVICIAN AND SILURIAN STRATIGRAPHY AND SEDIMENTATION IN SOUTHERN MANITOBA, CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 10, p. 2333-2398, 13 maps, 8 secs., diag., Oct. 1959, 49 refs.

Ordovician and Silurian strata in southern Manitoba are composed of shelf-type sediments that com-

prise in ascending order the Winnipeg (shale and sand), Red River, and Stony Mountain formations and Interlake group (carbonates).

Paleozoic sedimentation commenced in Late or possibly Middle Ordovician time with deposition of quartzose sand and green shale on a peneplaned surface in Precambrian (and local Cambrian) rocks in southern Manitoba. Initially, considerable sand and interbedded shale were laid down in the western areas, whereas mainly green shales accumulated at the E. Thence, during upper Winnipeg time, a large E.-trending sand body (more than 125 mi. long, 20-40 mi. wide, and up to 90 ft. thick) was deposited in the Carman area, and it now extends eastward from Pelican Lake to the subcrop SE. of the city of Winnipeg. It is postulated that approximately in middle Winnipeg time differential tectonic movements in the eastern area caused an E.-trending break in slope, S. of which quartz sands were laid down in shallow water, forming the Carman sand body, whereas nondeposition and slight erosion may have occurred N. of this line. This was followed by uniform subsidence and dominantly shale deposition in all areas to the end of Winnipeg time.

The lower Red River bioclastic limestones (containing basal transitional argillaceous beds) that accumulated next were affected by penecontemporaneous or diagenetic dolomitization. Where the latter process was incomplete, irregular areas of the matrix of calcarenites were most readily dolomitized to produce characteristic mottling. Of the fossils, crinoid ossicles were most resistant to dolomitization. Secondary chert nodules formed partly after dolomitization.

Extensive shoals developed during the latter part of Red River deposition, and an evaporitic environment prevailed, especially in the western part of southern Manitoba. Here, cream-colored and extremely fine-textured (microcrystalline and cryptocrystalline) dolomites that are associated with anhydrite are interpreted to be both secondary and primary in origin. Eastward, increasing amounts of very fine crystalline dolomites occur. Relict pseudo-oölitic and bioclastic textures in secondary dolomite suggest that there was considerable differentiation of shoal and intershoal environments during late Red River sedimentation.

Lowering of the depositional profile of equilibrium largely removed the restriction imposed by carbonate shoals, and gray bioclastic, fossiliferous limestones (lower Stony Mountain) containing argillaceous material were deposited. In part of the western area, the limestones were subject to penecontemporaneous dolomitization.

Extremely fine-textured dolomite, exhibiting relict pseudo-oölites and bioclastic grains, in the upper Stony Mountain (Gunton member) indicate a return to bank-type deposition. Arenaceous, silty, and argillaceous material also was transported into southern Manitoba, particularly toward the termination of Stony Mountain time. Quartz sands were concentrated in interpreted shoal areas E. of Daly field and in the southeastern part of the map area.

Fine-textured cream dolomites also occur in the approximate lower 150 ft. of the Interlake group within which the Ordovician-Silurian time boundary is placed. Above, very fine to medium crystalline dolomites are characteristic. Thin biostromes and small patch reefs (coral, algal, or stromatoporoidal) containing brachiopods, similar to those described in outcrops, are probably present in the subsurface. Presence of relict oölitic, pseudo-oölitic or pelletoid, and bioclastic textures in secondary dolomite indicates the diversity of carbonate types that formed on this ancient bank.

The Ordovician and Silurian sequences contain potential petroleum reservoirs, including porous quartzose sands (Winnipeg) and fine to medium crystalline porous dolomites (Red River, Stony Mountain, Interlake). Petroleum accumulations may occur in porous rocks that change facies to nonpermeable rocks up regional dip as well as laterally along strike where anticlinal folds are not present. Porous Interlake dolomites may be sealed by underlying and overlying nonpermeable strata at the pre-Middle Devonian unconformity where the latter truncates the Silurian rocks up regional dip (eastward) and is overlain by Ashern redbeds. --Auth.

1-2750. Summerson, C.H. EVIDENCE OF WEATHERING AT THE SILURIAN-DEVONIAN CONTACT IN CENTRAL OHIO: Jour. Sed. Petrology, v. 29, no. 3, p. 425-429, sec., graph, Sept. 1959, 10 refs.

Preservation of a lens of Hillsboro-like sandstone at the Silurian-Devonian disconformable contact in Madison County, Ohio, coincides with the presence of a dolomite pebble basal conglomerate with a red clayey matrix. Analysis of the minerals in the red matrix and study of the features of the underlying dolomite suggest that a portion of a pre-Devonian weathered surface has been preserved. The presence of such a clay mineral assemblage in other similar geologic circumstances may provide a criterion for the identification of an unconformity. --Auth.

1-2751. Fong, George. TYPE SECTION SWAN HILLS MEMBER OF THE BEAVERHILL LAKE FORMATION: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 5, p. 95-108, map, 2 secs., May 1959, 24 refs.

Currently popular names being used to describe the producing unit in the Swan Hills area are incorrect because they lack precision and presuppose correlations with established outcrop or subsurface sections without proof of stratigraphic continuity. The producing unit is defined in this paper as the Swan Hills member of the Beaverhill Lake formation [Devonian]. In the type section it is clastic, organic limestone member 333 ft. thick, overlying anhydritic beds of the basal Beaverhill Lake and underlying dense limestones and shales of the upper Beaverhill Lake. It carries a fauna indicating the uppermost part of the Lingula spatulata zone of the Waterways formation. --Auth.

1-2752. Moore, Derek. ROLE OF DELTAS IN THE FORMATION OF SOME BRITISH LOWER CARBONIFEROUS CYCLOTHEMS: Jour. Geology, v. 67, no.5, p. 522-539, 9 maps, 4 secs., 3 tables, Sept. 1959, 29 refs.

Well-developed cyclothems are characteristic of the Yoredale series of the lower Carboniferous in northern England and Scotland. Each cyclothem consists of up to 8 members, all impersistent, some especially so. The presence of the top 3 members is conditional upon the occurrence of sandstone. A maximum of 8 major cyclothems is present in the English outcrops; some of the major cyclothems contain minor cyclothems of much more restricted extent, whose appearance is again conditional upon the occurrence of sandstone in the major cyclothem. Individual cyclothems have not yet been traced into the Scottish outcrops.

Each major cyclothem is the result of interplay of 2 environments: a shallow epicontinental sea,

whose normal sediment was limestone, and the delta of a large river draining the continent N. of the sea. Comparison of the ancient delta with that of the Mississippi River suggests that the ancient delta advanced laterally down the coast of the continent, pushing out southwestward from the mouth of the alluvial valley. Regional subsidence, slower than delta deposition but continuing after the delta built up above sea level, gradually drew the bypassed parts of the delta plain below the sea. Finally, when the active head of the delta lay far to the SW. of the alluvial valley, major crevassing of the trunk river caused abandonment of the old delta and the initiation of the new. In the meantime the old delta sank below sea level, and limestone was deposited upon its surface by the encroaching sea. The mechanism of cyclic advance of the delta is sufficient to account for all the observed features of the Yoredale series cyclothems without recourse to more fanciful ideas. --Auth.

1-2753. Sanders, Donald T. SANDSTONES OF THE DOUGLAS AND PEDEE GROUPS IN NORTHEASTERN KANSAS: Kansas, State Geol. Survey, Bull. 134, pt. 3, p. 125-159, 4 maps (2 in pocket, scale approx. 2 1/2 in. to 15 mi.), sec., 8 graphs, 3 tables, 1959, 36 refs.

Sandstones of the Douglas and Pedee groups (Upper Pennsylvanian) in northeastern Kansas occupy definite channellike trends, which are interpreted as being ancient river valleys. Isolith maps of sandstones above and below the Haskell limestone show major features of this drainage pattern and indicate that little or no sandstone is present in much of the area. The deepest channel (i.e., trend of thickest sandstone) above the Haskell limestone trends in an irregular westerly direction across Wabaunsee, Osage, and Franklin counties, and main sandstone deposition below the Haskell limestone was in a deep channel extending southwestward through Douglas, Franklin, Osage, Coffey, Lyon, and Greenwood counties. Sandstone as much as 160 ft. thick was found in each of these stratigraphic units.

A few samples of Ireland and Tonganoxie sandstone, the most important units in the sequence, were analyzed, and all samples were found to have similar physical characteristics. Fine to very fine sand is predominant in both sandstone, but the Ireland contains a larger percentage of silt. Subangular to angular quartz grains make up 90 to 95% of the volume of all samples, the remainder being composed of muscovite, some tourmaline, and rare chlorite grains. Permeability is uniformly low, although both of these sandstones are important aquifers in northeastern Kansas. Results of this study should aid in locating new sources of ground water and possibly in developing underground storage reservoirs for surface water. --Auth.

1-2754. Halbertsma, H.L. NOMENCLATURE OF UPPER CARBONIFEROUS AND PERMIAN STRATA IN THE SUBSURFACE OF THE PEACE RIVER AREA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 5, p. 109-118, map, chart, 4 secs., 2 graphs, May 1959, 10 refs.

Four new formation names are proposed for Paleozoic strata above the Mississippian Debolt formation and below the Triassic Spray River formation in the Peace River area. The first 2 formations embrace the strata defined as the Stoddart formation by Rutgers. These are the Golata and Kiskatinaw formations (Mississippian) and the Taylor Flat formation (Pennsylvanian). The name Belloy is proposed for the Permian formation, often referred to as Permo-Pennsylvanian, which lies unconformably on the Pennsylvanian and Mississippian beds. The new nomenclature was considered necessary because Rutger's work was done without the benefit of age determinations which are now available. The newly proposed formations are distinctive mappable units. --Auth.

1-2755. Tanner, William F. PERMO-PENNSYLVANIAN PALEOGEOGRAPHY OF PART OF OKLAHOMA: Jour. Sed. Petrology, v. 29, no. 3, p. 326-335, 5 figs. incl. 4 maps, Sept. 1959.

Late Pennsylvanian and early Permian rocks, exposed in central Oklahoma, contain facies changes, fossils, pebbles, cross-bedding, and other diagnostic features which permit a paleogeographic map to be drawn for the area. It is recognized that the sea, throughout much of the area, was shallow (zero to perhaps 200 ft. deep), and that the sea floor was almost without relief. It is, therefore, obvious that the strand line may have oscillated widely. Nevertheless, agreement among the various bits of evidence is good enough that representative shoreline positions and orientations can be drawn. The sea indicated on the map appears to have withdrawn in, approximately, a northwesterly direction. --Auth.

1-2756. Stafford, Philip T. GEOLOGY OF PART OF THE HORSESHOE ATOLL IN SCURRY AND KENT COUNTIES, TEXAS: U.S. Geol. Survey, Prof. Paper 315-A, p. 1-20, 4 illus., 7 maps (6 in pocket), 6 secs. (5 in pocket), 2 graphs, 2 logs (1 in pocket), 1959, 33 refs.

The subsurface Horeshoe atoll is an arcuate accumulation of fossiliferous limestone 70 to 90 mi. across in the northern part of the Midland basin, in western Texas. The stratigraphy, the lithologic character of the rocks, and the petroleum reservoirs of the southeastern part of the atoll in Scurry County and parts of adjacent counties are described herein.

Rocks of Strawn, Canyon, and Cisco ages, belonging to the Pennsylvanian system, and rocks of Wolfcamp age, belonging to the Permian system, form the Horseshoe atoll. Reworking of these rocks at several times during the growth of the atoll has resulted in the formation of large amounts of limestone breccia, in the mixing of the fusulinid faunas used to date the rocks, and in the complex age relations between rocks in different parts of the atoll. Thin beds of shale within this limestone mass are the only lithologic units that can be correlated for any appreciable distance in the atoll, but studies of micrologs from wells penetrating the atoll have revealed many zones of low porosity that can be correlated with reasonable certainty over much of the area described in this report.

The atoll rests on a platform of bedded limestone and shale, which has been designated as equivalent in age to the Bend and Strawn groups of the Pennsylvanian system. It is covered mainly by shale, which has been designated as equivalent in age to the Wolfcamp series of the Permian system and is partly equivalent in age to the youngest rocks within the atoll.

Reworking of the rocks, the complex distribution of rocks of different ages, the presence of thin beds of shale, and the stratification of porosity in the atoll suggest that this structure has many of the characteristics of a reef. Its growth in the Midland basin was

apparently cyclic and may have been related to changes of sea level during the late Pennsylvanian and early Permian periods.

Oil is contained in porous zones within the atoll, mainly in reservoirs in hills along the crest of the structure where the overlying shale formed an impervious cap, but some is found in the lower part of the limestone mass where the reasons for the oil traps are not as apparent. The source of the oil was probably the shale of the Wolfcamp age that surrounds the atoll. --Auth.

1-2757. Stewart, John H., George A. Williams, Howard F. Albee, and Omer B. Raup. STRATIGRAPHY OF TRIASSIC AND ASSOCIATED FORMATIONS IN PART OF THE COLORADO PLATEAU REGION. With a Section on Sedimentary Petrology by Robert A. Cadigan: U.S. Geol. Survey, Bull. 1046-Q, p. 487-576, 11 maps, 4 charts (1 in pocket), sec., 17 tables, 1959, 45 refs.

Stratigraphic studies of the Triassic and associated formations were made in southeastern Utah and adjoining parts of Colorado and Arizona. Five principal lines of investigation were followed: regional stratigraphy, sedimentary petrology, pebble studies, sedimentary-structure studies, and lithofacies studies.

The formations studied are the Cutler formation, Coconino sandstone, and Kaibab limestone of Permian age; the Moenkopi formation, Chinle formation, and Wingate sandstone of Triassic age; the Kayenta formation of Jurassic (?) age; and the Navajo sandstone of Jurassic and Jurassic (?) age.

The Cutler formation grades from a conglomeratic facies in southwestern Colorado to a unit containing alternating reddish siltstone and yellowish-gray sandstone members in southeastern Utah. The reddish siltstone members comprise the Halgaito, Organ Rock, and Hoskinnini tongues. These alternate with the yellowish-gray sandstone members - the Cedar Mesa, White Rim, and De Chelly sandstone members.

The conglomeratic facies of the Cutler is classified as an arkose that was deposited by streams flowing westward from a rising granitic area in southwestern Colorado. The reddish siltstone members were deposited by quiet water in basin of accumulation on a slowly sinking continental margin, and they, also, were derived from a source area in southwestern Colorado. The Organ Rock tongue is part graywacke and part arkose, whereas the Hoskinnini tongue is arkose. The yellowish-gray sandstone members were deposited by winds blowing toward the SE., and the materials probably were derived from a source area to the NW. The Cedar Mesa sandstone member is feldspathic orthoquartzite, and the De Chelly sandstone member is tuffaceous feldspathic orthoquartzite.

The Coconino sandstone and Kaibab limestone crop out in the western part of southeastern Utah. The Coconino is laterally equivalent to part of the Cutler formation and is an eolian deposit formed by southeastward-blowing winds. The Kaibab is a marine deposit.

The Moenkopi formation of Triassic age consists of reddish horizontally and ripple-laminated siltstone that is classified as arkose and some cross-stratified sandstone of moderately well sorted sand that is classified as feldspathic orthoquartzite. The Sinbad limestone member crops out in central and S.-central Utah and to the S. overlaps the underlying part of the Moenkopi. The Moenkopi is 900 ft. thick in the Capitol Reef area and thins to a depositional margin along the Utah-Colorado boundary.

The Moenkopi formation in southeastern Utah is predominantly a tidal-flat deposit containing some stream-deposited material. The streams flowed westward from a highland in southwestern Colorado. The Sinbad limestone member is a marine deposit. The sea of Moenkopi time transgressed southeastward and eastward across Utah.

The Chinle formation in southeastern Utah and in Monument Valley, Arizona, is divided into 7 members, which are, in ascending order, the Temple Mountain, Shinarump, Monitor Butte, Moss Back, Petrified Forest, Owl Rock, and Church Rock members.

The Temple Mountain member is composed of mottled purple and white siltstone and claystone and minor amounts of yellowish-gray sandstone and conglomerate. It averages about 20 ft. in thickness and is restricted to the San Rafael swell area, in central Utah.

The Shinarump member is fine- to coarse-grained sandstone, composed of poorly to moderately well sorted sand, and conglomeratic lenses composed dominantly of siliceous pebbles. The Shinarump is feldspathic orthoquartzite with regional and local variations ranging from tuffaceous feldspathic orthoquartzite to arkose. It ranges in thickness from 0 to about 250 ft.

The Monitor Butte member consists of greenish bentonitic claystone and interstratified grayish sandstone, which is composed of very fine poorly sorted materials, and ranges in thickness from 0 to 250 ft. The sandstone in the Monitor Butte member is feldspathic orthoquartzite with local and regional variations that range from tuffaceous feldspathic orthoquartzite to arkose.

The Moss Back member is composed of grayish sandstone that consists of very fine- to medium-size poorly sorted sand and averages about 60 ft. in thickness. The Moss Back ranges in composition from orthoquartzite to arkose and contains some graywacke.

The Petrified Forest member consists of variegated bentonitic claystone and clayey sandstone composed of poorly sorted sand and ranges in thickness from 0 to 700 ft. The sandstone in the Petrified Forest member is orthoquartzitic tuff.

The Owl Rock member is composed of reddish siltstone and limy sandstone of moderately well sorted material interstratified with thin limestone beds and ranges in thickness from 0 to 450 ft. The detrital units in the Owl Rock are tuffaceous arkose.

The Church Rock member consists of reddish siltstone and minor reddish sandstone composed of moderately well sorted sand and ranges in thickness from 0 to 350 ft. The Church Rock member has 2 compositional classifications: the sandstone is arkose and the siltstone is graywacke.

The Chinle formation is a continental deposit formed under alluvial-plain and lake or lagoonal environments. The Shinarump, Monitor Butte, Moss Back, and Petrified Forest members contain much volcanic debris. Cross-stratification studies indicate that sandstone strata of the Chinle of southeastern Utah were derived from a source to the S. and SE.

The Glen Canyon group in southeastern Utah consists of the Wingate sandstone, Kayenta formation, and Navajo sandstone. Preliminary studies indicate that the sedimentary structures dip SE. to SW. in this area. The Wingate sandstone is composed of moderately to well sorted very fine-grained sand and ranges in composition from tuffaceous arkose to feldspathic orthoquartzite. The sandstone of the Kayenta formation consists of well sorted very fine-grained material and is feldspathic orthoquartzite or arkose,

depending on the amount of kaolin present. The Navajo sandstone is well sorted very fine-grained feldspathic orthoquartzite.

Most of the U deposits in the Triassic rocks are in the Shinarump, Monitor Butte, and Moss Back members of the Chinle formation, and in the base of undifferentiated Chinle. The deposits are generally near the base of the Chinle, regardless of which unit of the formation lies in that position. The deposits lie in broad northwestward-trending belts near the N. limit of the respective units.

Many determinations have been made of the types of clay minerals in the sandstones in the Triassic and associated formations. Evidence supports the hypothesis that much of the hydromica in the Chinle is the result of alteration of montmorillonite in the presence of soluble K salts.

Thin-section studies of ore-bearing sandstone and barren sandstone in the Shinarump and Moss Back members of the Chinle formation suggest that U ore occurs predominantly in sandstone that contains 20% or more kaolin, and that strata containing 15 to 35% kaolin should be considered more favorable for the occurrence of U than strata containing less than 15% kaolin. --Auth.

1-2758. Hawryszko, J.W. A GLAUCONITIC UNIT IN THE FERNIE GROUP NORTH OF JASPER PARK: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 1, p. 7-9, map, Jan. 1959, 3 refs.

A unit consisting of green glauconitic sandstones and dark green shale occurs in the lower part of the Fernie group [Jurassic] immediately to the N. of Jasper Park. A glauconitic zone has not been hitherto described in the Fernie group N. of the Bow River and no glauconitic beds at all have been previously described in the lower Fernie. --Auth.

1-2759. Fuente Navarro, José M. de la. PALEOGEOGRAFIA Y DISTRIBUCION DE LOS SEDIMENTOS TERCIARIOS EN LA CUENCA DE VERACRUZ [PALEOGEOGRAPHY AND DISTRIBUTION OF TERTIARY SEDIMENTS IN THE VERACRUZ BASIN]: Asoc. Mexicana Geólogos Petroleros, Bol., v. 11, no. 1-2, p. 21-50, 13 maps (11 facing p. 1), fold. chart, 3 secs., diag., table, Jan.-Feb. 1959, 7 refs.

Geologic data from subsurface and surficial deposits, available to date in the Cenozoic basin of Veracruz, have furnished the means by which the stratigraphic and paleogeographic conditions of the sediments in the basin have been established.

To date, 75 holes have been drilled in the Veracruz basin in search of hydrocarbons, the formations of Cretaceous age being the oldest uncovered by the drill. These formations, in the majority of cases, lie unconformably below Tertiary sediments, in which one can observe peculiar tectonic effects subsequent to the Laramide revolution.

The faunal and lithologic characteristics, as well as stratigraphic and tectonic phenomena, indicate a long period of sea regression which terminated in the northern part of the basin at the end of the late Oligocene, and in the southern part at the conclusion of the middle Oligocene.

A phase of transgression was subsequently initiated which terminated in the middle Miocene, the sea withdrawing in the late Miocene until it occupied its present position.

The previous movements began at the end of the Coniacian and ended in the Maestrichtian, initiating the Laramide revolution at the beginning of the Cenozoic, acting with greatest intensity during the middl[illegible] Eocene, and having later localized movements towar[illegible] the middle of the Miocene, lower Encanto.

As many Cretaceous sediments as Tertiary posse[illegible] lithologic qualities favorable for the accumulation of hydrocarbons, and sea movement favored the develo[illegible] ment of unconformities which could serve as traps that in the future could have great commercial value[illegible] --Auth. (transl. by J. Krauss)

1-2760. Murray, Grover E., James A. Wolleben, and Donald R. Boyd. DIFUNTA STRATA OF TERTIARY AGE, COAHUILA, MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 10, p. 2491-2495, map, Oct. 1959, 20 refs.

The youngest strata of the Difunta group of the Parras basin, southeastern Coahuila and western Nuevo León, Mexico, are shown to be of lower Paleocene age by the presence of Cimomia sp. cf. C. haltomi (Aldrich) and Hercoglossa n. sp. aff. H. fricator. However, the bulk of the Difunta beds contain definite Cretaceous fossils. Previous work had uncovered no Tertiary fossils.

Field investigations demonstrate a maximum thickness of 11,000 ft. which can be broken down into 2 gross lithic units: 1) marine sand and shale sequence (fossiliferous) and 2) a series of red bed tongues of sands, silts, and shales (unfossiliferous). In general, the structure is a series of E.-W.-trending anticlines and synclines.

The new data indicates that this portion of the Parras basin was: 1) actively negative until sometime in the Paleocene (Midwayan); 2) undergoing continuous deposition from the late Gulfian (Upper Cretaceous) into Paleocene time, spanning the Mesozoic-Cenozoic time boundary; 3) deformed and uplifted sometime between late Paleocene and late Tertiary time. --I. M. Johnston.

1-2761. Obregon de la Parra, Jorge. CONSIDERACIONES SOBRE EL DANIANO EN LA CUENCA SEDIMENTARIA DE TAMPICO-MISANTLA [CONSIDERATIONS ON THE DANIAN IN THE SEDIMENTARY BASIN OF TAMPICO-MISANTLA]: Asoc. Mexicana Geólogos Petroleros, Bol., v. 11, no. 1-2, p. 13-20, 2 illus., map, chart, Jan.-Feb. 1959, 25 refs.

The object of the present work is to define the biostratigraphic characteristics of the Paleocene of the sedimentary basin of Tampico-Misantla, based on the results of studies carried out in the Ebano-Pánuco zone in Tulillo, San Luis Potosí, and in a road cut on the road from Xolol to Cd. Santos, S. L. P., (before Tancanhuítz).

The presence of Globigerina mud in the Paleocene base, and also of fauna corresponding to the Paleocene of Europe and other regions, indicate without a doubt that the same ecologic conditons must have existed simultaneously in all of these regions, as well as similar geologic events. --Auth. introd. (transl. by J. Krauss)

1-2762. Bonet, F. AFLORAMIENTOS DEL EOCENO EN EL NORTE DE LA PENINSULA DE YUCATAN [EOCENE OUTCROPS IN THE NORTH OF THE YUCATAN PENINSULA]: Asoc. Mexicana Geólogos Petroleros, Bol., v. 11, no. 1-2, p. 1-12, 12 illus. on 2 pls., Jan.-Feb. 1959, 28 refs.

The presence of abundant specimens of Coskinolina floridana in samples collected by R. Robles Ramos between kilometers 103-113 of the Mérida-Chichén

Itzá road demonstrates beyond a doubt the presence of a structural high intruding a zone of strata, perceptibly horizontal, generally thought to be of Pliocene age. This fossil indicates an age corresponding to the middle-upper Eocene. --Auth. (transl. by J. Krauss).

1-2763. Frye, John C., and A. Byron Leonard. CORRELATION OF THE OGALLALA FORMATION (NEOGENE) IN WESTERN TEXAS WITH TYPE LOCALITIES IN NEBRASKA: Texas, Univ., Bur. Econ. Geology, Rept. Inv. no. 39, 46 p., 3 figs., 2 pls., Aug. 1959, 78 refs.

The Ogallala formation extends from the N. side of the Pecos valley northward across western Texas, Oklahoma, Kansas, and Nebraska into southern South Dakota. With its southern limit within the Edwards plateau, it underlies the upland surface of much of the High Plains section of the Great Plains province. The extensive fluvial deposits of Neogene age are widely exposed throughout the dissected plateau region that flanks the Rocky Mountains on the E. The deposits have yielded large faunas of fossil vertebrates and mollusks and an abundance and variety of fossil plant seeds. Relief on the sub-Ogallala erosion surface accounts for the range in thickness of the formation from a feather edge to more than 500 ft.

The lithology of the formation from Nebraska to central western Texas is discussed, criteria for correlation are considered, and the work on fossil vertebrates, mollusks, and fossil plant seeds is briefly reviewed, with the purpose of correlating the Ogallala formation of central western Texas with previously recognized type localities in Nebraska. Classification problems are discussed, and it is concluded that rock-stratigraphic subdivision of the Ogallala of Texas is not usable regionally, whereas floral zones are recognizable throughout the High Plains. Three floral zones recognized in the Texas Ogallala are correlated with the Valentine Ash Hollow, and Kimball of Kansas and Nebraska. --Auth.

1-2764. Ketner, Keith B., and Lawrence J. McGreevy. STRATIGRAPHY OF THE AREA BETWEEN HERNANDO AND HARDEE COUNTIES, FLORIDA: U.S. Geol. Survey, Bull. 1074-C, p. 49-124, 2 maps (1 in pocket), 2 secs. (1 in pocket), diag., graphs, 2 tables, 1959, 22 refs.

Eocene, Oligocene, Miocene, and Recent rocks are exposed between Hernando and Hardee counties. Eocene and Oligocene formations are fossiliferous limestone, but Miocene rocks are largely unconsolidated sands and clays in which fossils are scarce. Correlation of Miocene strata, therefore, is based mainly on lithology and stratigraphic position. Where rocks are altered by weathering, correlation is based on original rather than present gross lithology. Quartz sand was found to be valuable in correlation because it is not affected by weathering.

Rocks previously mapped as the Pliocene Alachua and Bone Valley formations range from lower to middle Miocene and are assigned to the Tampa and Hawthorn formations. The Citronelle formation of Pliocene or later age apparently does not extend into peninsular Florida. Clayey, micaceous sand, which has been considered as an equivalent of Citronelle, is late middle Miocene or early late Miocene in age.

Hard-rock phosphate deposits in the area are in beds of early Miocene age, which are assigned to the Tampa limestone. Hard-rock phosphate particles appear to consist of 2 types: cementation concretions and limestone replacements.

Land-pebble phosphate deposits range from middle Miocene to Pleistocene in age. They are chiefly residual deposits of middle Miocene age. U is confined mainly to lower and middle Miocene rocks with the greatest concentrations in the Hawthorn formation. --Auth.

1-2765. Crouch, Robert W. INSPISSATION OF POST-OLIGOCENE SEDIMENTS IN SOUTHERN LOUISIANA: Geol. Soc. America, Bull., v. 70, no.10, p. 1283-1292, fold. map, table, Oct. 1959, 13 refs.

The aggregate thickness between stratigraphic markers of post-Oligocene sediments in southern Louisiana, established from records of several thousand wells, is at least 62,000 ft.

The sediments along the Texas-Louisiana coast accumulated rapidly in rim synclines and in an area of "hinge-line" faults. Composite thicknesses are as follows: Miocene, 48,000 ft.; Pliocene, 6,000 ft.; Pleistocene (including Recent and modern), 8,000 ft. An additional 7,100 ft. of sediment is present in areas where no basal markers were found.

Because the unconsolidated beds in southern Louisiana reflect poorly, the geophysical data give an erroneous regional picture. Foraminiferal data and electric-log correlations together can give an adequate regional interpretation.

No valid evidence supporting the suggested regional reversal of dip or regional thinning of section can be found in any of the deep wells drilled in southern Louisiana. In spite of this, most workers in the area believe that a geosyncline of some type exists. No single center of deposition for post-Oligocene sediments can be established in a given geographic position. Each geologic subdivision possesses its own depositional axis at some unknown geographic point offshore. --Auth.

1-2766. Martin, L. John. STRATIGRAPHY AND DEPOSITIONAL TECTONICS OF NORTH YUKON-LOWER MACKENZIE AREA, CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 10, p. 2399-2455, 24 maps, sec., 2 tables, Oct. 1959, 83 refs.

The N. Yukon-lower Mackenzie area lies in the northwestern corner of Canada, between the 65th parallel and the Arctic coast, the 125th meridian and the Alaska boundary.

Strata of every Paleozoic and Mesozoic system as well as rocks of Precambrian and Tertiary age are present in the area. Dominant rock types are as follows: Precambrian and Lower Cambrian - clastics; Middle and Upper Cambrian - carbonates; Ordovician and Silurian - carbonates, black shales, and bedded cherts; Middle Devonian - carbonates and shales; Upper Devonian - clastics; Mississippian - carbonates; Upper Pennsylvanian and lower Permian - clastics; Triassic - shales and limestones; Jurassic and Cretaceous - clastics; Tertiary - clastics.

Most of the eastern part of the area has formed part of the cratonic interior of the continent since Precambrian time. Basins have occupied parts of the western half and southern margin of the area at many times, and these regions have generally exhibited relatively high tectonic activity. Mountain-building movements took place in the British Mountains-Barn Mountains area, probably during late Middle Devonian or Upper Devonian. Upper Devonian sediments believed to be in part derived from this

disturbed area form a depositional body that is in many respects similar to the Catskill delta.

An uplift of the ancestral Rockies type appeared in the northern Richardson Mountains during the Pennsylvanian. The uplift was flanked by a complementary basin.

Laramide deformation strongly affected the western and southern parts of the area. Faulting of the Canadian Rockies type occurred in the area of the northern Ogilvie and northwestern Richardson mountains. The southern Richardsons are formed by an anticline of the Wyoming Rockies type. --Auth.

1-2767. Milhous, H.C. WELL LOGS IN TENNESSEE: Tennessee Dept. Conserv., Div. Geology, Bull. 62, 606 p., map (fold. in pocket) scale 1 in. to 16 mi., 1959.

A compilation of subsurface information that has accumulated over a period of almost 100 years. Existing records are mostly in the form of drillers' logs and sample descriptions, which cover approximately 560 holes drilled in 68 of Tennessee's 95 counties. --R. J. Floyd.

1-2768. Hussey, Arthur M., II. AGE OF INTERTIDAL TREE STUMPS AT WELLS BEACH AND KENNEBUNK BEACH, MAINE: Jour. Sed. Petrology, v. 29, no. 3, p. 464-465, table, Sept. 1959, 2 refs.

Stumps of white pine ranging from 1-10 in. in diameter and rooted in peat 1-2 ft. thick were exposed as a result of scouring in 1955 at Wells Beach, Maine. Radiocarbon dates are 2,810 ± 200 and 2,980 ± 180 years. Two occurrences of intertidal stumps at Kennebunk Beach, Maine, were 1,280 ± 200 (red pine) and 3,250 ± 200 (white pine). The ages of the stumps indicate that a lower sea level prevailed for an undetermined length of time prior to about 3,000 years ago. --D. Carroll.

1-2769. Jaffe, Howard W., David Gottfried, Claude L. Waring, and Helen W. Worthing. LEAD-ALPHA AGE DETERMINATIONS OF ACCESSORY MINERALS OF IGNEOUS ROCKS (1953-1957): U.S. Geol. Survey Bull. 1097-B, p. 65-148, Oct. 1959, 70 refs.

The U. S. Geological Survey completed Pb-alpha age determinations of accessory minerals from about 400 rocks between July 1953 and Jan. 1957. All the ages and the experimental data, equations, and constants from which they were calculated are given in tabular form. A citation of the most probable geologic age of each rock is included for comparison with the measured age. The tabulation is followed by a geographic index of sample localities. --Auth.

5. PALEONTOLOGY

See also: Areal and Regional Geology 1-2699; Stratigraphy 1-2747; Sedimentary Petrology 1-2865.

1-2770. Smith, A. Barrett. PALEOECOLOGY OF A MOLLUSCAN FAUNA FROM THE TRENT FORMATION: Jour. Paleontology, v. 33, no. 5, p. 855-871, map, 2 tables, Sept. 1959, 56 refs.

A new locality of the Miocene Trent formation was discovered at Silverdale, Onslow County, North Carolina. Here the formation is an unconsolidated shell marl. The fauna is entirely molluscan.

A complete faunal list for the Trent is given showing the species collected by earlier investigators and the number of specimens of each species collected at the new site. The ecology of Recent species of the genera collected from Silverdale was studied from the literature. From this data, the paleoecology of the community was interpreted.

The Silverdale community lived in marine waters at depths of about 3 to 22 fathoms. The temperature of the water was from 7 to 40°C. with the average high near 28 to 30°C. The mollusks lived on a sandy to muddy sand substrate in moderately swift currents. --Auth.

1-2771. Watkins, J. Lloyd. MIDDLE DEVONIAN AULOPORID CORALS FROM THE TRAVERSE GROUP OF MICHIGAN: Jour. Paleontology, v. 33, no. 5, p. 793-808, 4 pls., Sept. 1959, 33 refs.

Twenty-five Middle Devonian species of tabulate corals are placed in the family Auloporidae. The species are assigned to the following genera, the last of which is new: Aulocystis, Aulopora, Syringopora, and Pachyphragma. The descriptions include 14 species of Aulocystis, 9 of which are new; 6 species of Aulopora, 3 of which are new; 2 species of Syringopora, 1 of which is new; and 3 species of Pachyphragma, 2 of which are new. --Auth.

1-2772. Nelson, Samuel J. MISSISSIPPIAN SYRINGOPORA OF WESTERN CANADA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 4, p. 91-92, graph, Apr. 1959.

A graphical method is presented by which the field geologist can plot diameter and frequency of corallites in Syringopora and thus determine specific horizons within the Mississippian system of western Canada. --Auth.

1-2773. Boucot, Arthur J. BRACHIOPODS OF THE LOWER DEVONIAN ROCKS AT HIGHLAND MILLS, NEW YORK: Jour. Paleontology, v. 33, no. 5, p. 722-769, 2 illus., 2 maps, chart, 14 pls., table, Sept. 1959, 17 refs.

A sequence of Lower Devonian rocks at Highland Mills, Orange County, includes (in ascending order) the Central Valley sandstone (new name), the Connelly conglomerate, the Highland Mills member (new name) of the Esopus formation, the middle member of the Esopus formation, the Woodbury Creek member (new name) of the Esopus formation, and the Kanouse sandstone. The Central Valley sandstone is of late Helderberg or Oriskany age, the Connelly conglomerate is of Oriskany age, the Highland Mills member is of post-Oriskany and pre-Woodbury Creek age, the middle member of the Esopus formation is unfossiliferous, the Woodbury Creek member is of post-Highland Mills and pre-Onondaga age, and the Kanouse sandstone is of Onondaga age.

The articulate brachiopod fauna of 39 forms and 2 new genera, is described. The fauna of the Highland Mills member is correlated with that occurring in the lower part of the Gaspe sandstone.

Emphasis is placed upon the recognition of stratigraphic breaks by study of the phylogeny of closely related genera present in the beds above and below a suspected break.

The developmentally and stratigraphically intermediate faunas of the Highland Mills and Woodbury Creek members lead to the recognition of an Esopus stage in the Early Devonian of the Appalachians. --Auth.

1-2774. Veevers, J.J. SIZE AND SHAPE VARIATION IN THE BRACHIOPOD SCHIZOPHORIA FROM THE DEVONIAN OF WESTERN AUSTRALIA: Jour. Paleontology, v. 33, no. 5, p. 888-901, illus., 7 diags., 3 graphs, table, Sept. 1959, 18 refs.

For brachiopods the only valid basis for reconstructing the size distribution of the original population before burial is complete sample composed of all the fossil specimens in a given continuous volume of rock. Of the 3 samples analyzed, one represents a living population in which possibly 2 age-groups may be recognized, another represents an assemblage which originated by the removal of small valves from a living population by a water current of low competent velocity, while the third, a noncomplete sample, gives inconclusive results. A critical comparison with Parkinson leads to the rejection of the part therein dealing with the comparison of means and variances. Higher degrees of linear correlation of characters in certain size-groups in the samples are probably related to the living position of the shell with respect to the pedicle. The change in shape at a width of approximately 21.5 mm. may be attributed to either environmental or genetic causes. --Auth.

1-2775. Veevers, J.J. THE TYPE SPECIES OF PRODUCTELLA, EMANUELLA, CRURITHYRIS AND AMBOCOELIA (BRACHIOPODA): Jour. Paleontology, v. 33, no. 5, p. 902-908, 7 figs. incl. illus., diags., Sept. 1959, 8 refs.

Topotypical material of the upper Paleozoic brachiopod genera Productella Hall 1867, Emanuella Grabau 1925, Crurithyris George 1931, and Ambocoelia Hall 1860 is described and figured. Special attention is given to internals and shell structure. Taleolae in Productella are rare. The lectotype of Emanuella takwanensis is chosen. The teeth in Crurithyris and Ambocoelia are small, unsupported either by dental plates or ridges. --Auth.

1-2776. McLearn, Frank H. REVISION OF SOME TRIASSIC AMMONOIDS, PEACE RIVER FOOTHILLS, BRITISH COLUMBIA: Can. Field-Naturalist, v. 73, no. 1, p. 53, Jan.-March 1959.

"Sirenites pardoneti McLearn... and similar species are now included Pseudosirenites Arthaber. The genus Vredenburgites Diener is recognized. Indoclionites? is recorded in the Monotis subcircularis zone. Thisbites charybdis (Gemmellaro) and T. cf. pyrami (Gemmellaro) occur in the Styrites ireneanus zone. The ventral tubercles and ventral keel of Thisbites dawsoni (McLearn)... and T. custi (McLearn) ...disappear adorally, are fainter than in T. charybdis, and are by no means as well defined as in Alpine T. agricolae Mojsisovics. 'Heraclites'? exquisitus McLearn... is included in Thetidites Mojsisovics. Tropites is recorded by only one specimen in place and at a horizon above the Stikinoceras zone and in the major Gonionotites-Malayites zone.

Although the genus Halorites Mojsisovics is not recorded, the family Haloritidae is well represented. Juvavites (Griesbachites) caurinus McLearn... is now placed in synonomy with J. (Anatomites) humi McLearn... The genus Griesbachites as now defined by Spath, that is, with ventrolateral tubercles on the phragmocone, does not occur in Geological Survey [Canada] collections. These tubercles, however, are found on the body chamber of J. selwyni McLearn ...the revised J. (Anatomites) humi, and on some Gonionotites. A single, poor specimen of Guembelites occurs in the Pterotoceras-Cyrtopleurites magnificus beds, suggesting a correlation with the Styrites-Guembelites zone of Nevada. Inner whorls of Gonionotites are ribbed, costate to smooth. Juvavites clavatus McLearn... with clavi at the ends of faint ribs is included in Gonionotites. Malayites includes typical species of the genus, and, in addition, smooth or nearly smooth species with very fine strigation, Malayites parcus (McLearn)... M. custi (McLearn)... and M. bococki (McLearn)..." F.H. McLearn.

1-2777. Flower, Rousseau H., and MacKenzie Gordon, Jr. MORE MISSISSIPPIAN BELEMNITES: Jour. Paleontology, v. 33, no. 5, p. 809-842, 5 pls., Sept. 1959, 23 refs.

New Mississippian belemnites comprise 3 new genera, containing 5 named and one unnamed new species. Eobelemnites? sp. is from the rocks of Chester age of Alabama. Other species are based upon 8 specimens from the Fayetteville shale of Arkansas and more than 250 specimens from the Chainman shale of Utah. The new morphologic terms septal line and neck lobe are proposed. Some of the new forms have phragmocones which are very close to those of true and supposed bactritids, raising the question as to whether some such supposed bactritids may be based upon exfoliated belemnoid phragmocones. Review of features of the Aulococeratidae indicates that its distinction from the Belemnitidae is not warranted. Details of morphology are discussed, not all of which are explained satisfactorily from the present material, notably, variation of the rostral tips, vesicular structure in the rostrum, thinness of conotheca and absence of a clear protoconch suggesting resorption of protoconch and early phragmocone within the rostrum. Both Belemnitidae and Belemnoteuthidae occur in Permian and Triassic; Mississippian forms are Belemnitidae, but show some diversity of form and structure suggesting an appreciably older derivation of the Coleoidea. --Auth.

1-2778. Wille, Alvaro. A NEW FOSSIL STINGLESS BEE (MELIPONINI) FROM THE AMBER OF CHIAPAS, MEXICO: Jour. Paleontology, v. 33, no. 5, p. 849-852, 5 illus., Sept. 1959, 6 refs.; also pub. as: Kansas, Univ., Dept. Entomology, Contr. no. 1027.

A new fossil stingless bee, Trigona (Nogueirapis) silacea closely related to the living T. butteli Friese, is described from middle Miocene and possible middle Miocene amber of Chiapas, Mexico. --Auth.

1-2779. Wygodzinsky, Pedro. A NEW HEMIPTERAN (DIPSOCORIDAE) FROM THE MIOCENE AMBER OF CHIAPAS, MEXICO: Jour. Paleontology, v. 33, no. 5, p. 853-854, 5 illus., Sept. 1959.

The first recorded fossil dipsocorid hemipteran insect, Ceratocombus (Ceratocombus) hurdi n. sp., is described from the middle Miocene of the Simojovel area, Chiapas, Mexico. --Auth.

1-2780. Beerbower, James R. and Mortimer H. Hait, Jr. SILURIAN FISH IN NORTHEASTERN

PENNSYLVANIA AND NORTHERN NEW JERSEY: Pennsylvania Acad. Sci., Proc. v. 33, p. 198-203, 2 figs., 1959, 10 refs.

Five new Silurian fish localities have been found recently in New Jersey and northeastern Pennsylvania. Two of these localities, near Delaware Water Gap, have yielded significant specimens. These fish, which occur in the upper part of the Bloomsburg (High Falls) formation, are of late Niagaran or early Cayugan age and may represent the same time interval as those known previously from Otisville, New York, and attributed by some authors to the Shawangunk formation (Albion or early Niagaran age). The occurrence at Water Gap village, Pennsylvania, suggests a fresh or brackish water environment, either fluvial (channel-floodplain pond) or lagoonal (tidal channel-tidal flat). The fossil fish are referred to the species Archegonaspis van ingeni (Bryant), previously collected at Otisville, and contribute significantly to knowledge of its morphology. --Auth.

1-2781. Brodkorb, Pierce. PLEISTOCENE BIRDS FROM NEW PROVIDENCE ISLAND, BAHAMAS: Florida State Mus., Bull., Biol. Sci., v. 4, no. 11, p. 349-371, 23 illus., map, 3 tables, 1959, 26 refs.

Only 4 of 15 species of birds from a Pleistocene deposit on New Providence still exist on the island. The other species either are extinct or occur now farther S. in the Bahamas and Greater Antilles. The extinct forms include 2 raptors previously known only from Great Exuma Island and 6 new species: Caracara creightoni, Burhinus nanus, Glaucidium dickinsoni, Otus providentiae, Bathoceleus hyphalus (new genus, Picidae), and Corvus wetmorei.

The fossil deposit is assigned to the pre-Pamlico portion of the Wisconsin glacial stage, when the sea had retreated to the 10-fathom mark to expose a large land mass which reached within 10 mi. of Cuba. At this time the avifauna of the Bahamas appears to have been about 40% richer than at present. The faunal tie to the Greater Antilles, particularly Cuba, was strong, while the relationship to Florida was weaker than today. --Auth.

1-2782. Macdonald, J.R. THE MIDDLE PLIOCENE MAMMALIAN FAUNA FROM SMITHS VALLEY, NEVADA: Jour. Paleontology, v. 33, no. 5, p. 872-887, 5 figs. incl. illus., map, Sept. 1959, 32 refs.

The mammalian fauna of the Smiths Valley area, Lyon County, Nevada, is described and its relationships are discussed. The fauna includes: Leporidae gen. indet., Aplodontidae gen. indet., ?Citellus sp., Pliosaccomys dubius Wilson, Pliozapus solus Wilson, Peromyscus near antiquus, Dipoides sp., Caninae gen. indet., Osteoborus sp., Indarctus nevadensis Macdonald n. sp., Felidae gen. indet., Mammut (Pliomastodon) nevadanus (Stock), Pliohippus cf. spectans, Aphelops sp., Prosthennops sp., ?Pliauchenia sp., Paracamelus sp., Antilocapridae gen. indet. A new name, Paracamelus brevirostrus, is proposed for Megatylopus gigas Matthew and Cook. This fauna is believed to be very close to the Rattlesnake fauna of Oregon in age as it contains a horse, Pliohippus cf. spectans, which may be co-specific with the Oregon species. An early Hemphillian age is also suggested by the primitive Dipoides, and the camel Paracamelus, from this fauna. --Auth.

1-2783. Howell, F. Clark. THE VILLAFRANCHIAN AND HUMAN ORIGINS: Science, v. 130, no. 3379, p. 831-844, 7 figs. incl. 2 maps, Oct. 2, 1959, appr 100 refs.

Present evidence indicates that continental Eurasi was not occupied by hominids during the Villafranchi stage. However, Africa affords numerous sites whe hominid remains have been found. Of these, the site containing australopithecine remains have produced the best evidence of hominid development during the early Pleistocene. A study of 4 australopithecine pelves indicate that this was a period when hominids became bipedal; other remains indicate the first use of tools to have possibly occurred then. --M. Russell

1-2784. Nelson, Samuel J. ARCTIC ORDOVICIAN FAUNA: AN EQUATORIAL ASSEMBLAGE?: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 3, p. 4 47, 53, map, March 1959, 11 refs.

Paleontologic evidence from the Red River-Stony Mountain interval suggests that the Ordovician equator extended in a northeasterly direction across North America. Polar wandering, continental drift, or rotation could explain this anomaly. --Auth.

1-2785. Bock, Wilhelm. THE EDISON FAULT AND THE PALEONTOLOGY OF SOME LOCKATONG BED Pennsylvania Acad. Sci., Proc., v. 33, p. 156-161, 3 figs., 1959, 10 refs.

A new substantial, well-exposed fault traversing the Edison quarry near Doylestown, Pennsylvania, is described, and the paleontological importance of this Triassic section is emphasized. The crustacean Isaura ovata (Lea) is found abundantly in association with the paleoniscid fish Turseodus acutus Leidy, the latter displaying ossified ringlike or cylindric vertebrae, so far unknown in this group of fish. On account of this important disclosure the new family Turseoidae is introduced for the different species and genera of this type of fish. From the lower Lockatong formation the medium-sized coelacanth Rabdiolepis gwyneddensis is described. --Auth.

1-2786. Bé, Allan W.H. A METHOD FOR RAPID SORTING OF FORAMINIFERA FROM MARINE PLANKTON SAMPLES: Jour. Paleontology, v. 33, no. 5, p. 846-848, illus., graph, pl., table, Sept. 1959, ; also pub as: Columbia Univ., Lamont Geol. Observatory, Contr. No. 364.

A method is described for the rapid removal of planktonic Foraminifera and other shelled organisms from marine plankton samples. Saturated sodium chloride solution (sp. gr. 1.20) is utilized for the density separation of the shelled plankton (sp. gr. 1.4 on the one hand and the nonshelled plankton (sp. gr. 1.09) on the other. The percentage of recovery of planktonic Foraminifera by weight and by number of specimens for 10 plankton samples average 93 and 79%, respectively. --Auth.

1-2787. Seiglie, George A. NOTAS SOBRE ALGUNA ESPECIES DE HETEROHELICIDAE DEL CRETACIC SUPERIOR DE CUBA [NOTES ON SOME SPECIES OF HETEROHELICIDAE OF THE UPPER CRECTACEOU OF CUBA]: Asoc. Mexicana Geólogos Petroleros, Bol., v. 11, no. 1-2, p. 51-62, 4 pls., 4 illus., 2 maps, Jan.-Feb. 1959, 11 refs.

The family Heterohelicidae has been one of the most problematic of the Foraminifera, especially the genus Pseudotextularia and its 2 controversial

species, Pseudotextularia elegans (Rzehak) and P. fructicosa (Egger). In our work on Cretaceous stratigraphy we were able to observe 5 species of this genus with well-defined characteristics, and perhaps can clarify some aspects of this question.

The species of the genus Pseudotextularia show rapid mutations, which, when they are better known, will have a notable stratigraphic significance.

There is also a description of a new species of the genus Pseudogümbelina Brönnimann and Brown.

Although the species described herein have been observed in various wells and surface samples in the Jatibonico basin, the specimens used in these descriptions are from 2 wells and 1 surface sample. The wells are El Cristales No. 1-A, situated approximately 8 km. NE. of the town of Majagua, Municipal District of Ciego de Avila, Province of Camagüey, and Catalina No. 2, situated about 4.2 km. S. 15°E. of the city of Jatibonico, in the same Municipal District and Province. The surface sample, D-14, was taken from a cutting at Viá Blanca, 2 km. W. of the Camino al Central Puerto, Province of Matanzas. --From auth. introd. (transl. by J. Krauss)

1-2788. Hanzawa, Shoshiro. OCCURRENCE OF THE FORAMINIFERAL SPECIES ACERVULINA LINEARIS HANZAWA FROM ST. BARTHOLOMEW I., FRENCH WEST INDIES: Jour. Paleontology, v. 33, no. 5, p. 843-845, 4 illus. on pl., table, Sept. 1959, 5 refs.

Acervulina linearis, an encrusting Foraminifera, known previously from the upper Eocene of the Indo-Pacific region, was found in middle Eocene limestones of St. Bartholomew, French West Indies. These specimens are described and illustrated. --Auth.

1-2789. Forbes, C.L., and A. McGugan. A LOWER PERMIAN FUSULINID FAUNA FROM WAPITI LAKE, B.C.: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 2, p. 33-42, 7 illus., 2 maps, sec., Feb. 1959, 12 refs.

A lower Permian fusulinid, Schwagerina emaciata (Beede), is described. This fauna occurs in beds which bear lithological affinities to the Norquay formation of the Banff area, and has been traced southwards to the Narraway River. The biofacies evidently has its southerly limit somewhere between the Narraway and the Jasper area, where no fusulinids have yet been found. --Auth.

1-2790. Thompson, Marcus L., Robert H. Shaver, and E.A. Riggs. EARLY PENNSYLVANIAN FUSULINIDS AND OSTRACODS OF THE ILLINOIS BASIN. PART I. PRIMITIVE FUSULINIDS IN THE SOUTHERN PART OF THE ILLINOIS BASIN. PART II. PENNSYLVANIAN OSTRACODS FROM MORGANTOWN, KENTUCKY: Jour. Paleontology, v. 33, no. 5, p. 770-792, illus., map, 4 pls., 11 tables, Sept. 1959, 35 refs.

Fusulinids are described or illustrated from an unnamed limestone near Morgantown, Butler County, Kentucky; from the Curlew limestone of Union and Crittenden counties, Kentucky; from the Boskydell? marine zone of the Delwood sandstone of Pope County, Illinois; and from a limestone considerably above the Delwood sandstone in Saline County, Illinois. They include Profusulinella kentuckyensis, n. sp., and numerous unnamed forms of Millerella and Paramillerella from near Morgantown; Fusulinella stouti and F. iowensis from the Curlew limestone; Fusulinella stouti? from the Boskydell? marine zone; and Fusulina serotina and F. aff. F. leei from the limestone of Saline County.

This first observation of Profusulinella E. of the Mississippi River demonstrates the presence of lower Derryan (lower Atokan) rocks in central Kentucky. The presence of numerous associated ozawainellids, such as Millerella spp. and Paramillerella sp., supports the interpretation that the containing rocks are of lower Middle Pennsylvanian age. The most primitive Pennsylvanian marine rocks that can be identified at the present time in the Illinois basin are in the eastern part of the basin in Kentucky and Indiana.

The ostracods described or illustrated from the limestone near Morgantown include 4 new, 3 previously described, and one unnamed form of Bairdia; 4 previously described forms of Fabalicypris; one unnamed form of Basslerella; one new species each of Healdia and Aurikirkbya; and one previously known form of Amphissites. They compare closely with the ostracods known from the lower part of the Dornick Hills group of the Ardmore basin, Oklahoma. --Auth.

1-2791. Johnson, J. Harlan, and Kenji Konishi. A REVIEW OF SILURIAN (GOTLANDIAN) ALGAE: Colorado School Mines, Quart., v. 54, no. 1, p. 1-114, 9 maps, sec., 29 pls., 8 tables, Jan. 1959, approx. 150 refs.

The available data on the calcareous algae of the Silurian is summarized in as nontechnical form as possible for use by the graduate student and practicing geologist. The fundamental ideas of classification are presented and the various known genera are described, but the species have only been tabulated. A fairly complete bibliography is appended. So-called "fucoidal" genera are covered both because of their abundance in Silurian strata in many areas and because of their long association in the public mind as algae. --From auth. pref.

1-2792. Rezak, Richard. NEW SILURIAN DASYCLADACEAE FROM THE SOUTHWESTERN UNITED STATES: Colorado School Mines, Quart., v. 54, no. 1, p. 115-129, 4 pls., Jan. 1959, 11 refs.

The fossils described represent a stage of development not previously known to have existed prior to late Permian time. The tribe Verticilloporeae, with its presently known representatives, Verticillopora annulata n. sp. and Phragmoporella monilis n. sp., has been recognized in the limestones and dolomites of Middle Silurian age in the southwestern United States. These forms represent an intermediate stage of development according to the phylogenetic relationships described by Julius Pia in 1912. This occurrence, in addition to the presence of the Primicorallineae in lower Paleozoic rocks, indicates an early development of rather advanced vegetative structures among the Dasycladaceae. --From auth. introd. and concl.

1-2793. Johnson, J. Harlan, and Kenji Konishi. SOME SILURIAN CALCAREOUS ALGAE FROM NORTHERN CALIFORNIA AND JAPAN: Colorado School Mines, Quart., v. 54, no. 1, p. 131-162, 10 pls., 3 tables, Jan. 1959, 8 refs.

The specimens are of special interest in that they show unusual structural features or represent new geological occurrences. Of particular interest are 1) a specimen of Dasyporella showing detailed struc-

tures which indicate it does not belong in the family Dasycladaceae; 2) a specimen of Solenopora filiformis Nicholson having structures which appear to represent either large sporangia or small conceptacles; and 3) an algal flora from the lower part of the Gazelle formation which appears to represent an Upper Ordovician rather than a Lower Silurian flora. --From auth. introd.

1-2794. Terasmae, Jaan. PALAEOBOTANICAL STUDY OF BURIED PEAT FROM THE MACKENZIE RIVER DELTA AREA, NORTHWEST TERRITORIES: Can. Jour. Botany, v. 37, no. 4, p. 715-717, 30 illus., table, July 1959, 5 refs.

A paleobotanical and palynological study of samples of buried peat from the Mackenzie River delta area, Northwest Territories, has shown that the peat accumulated during an interglacial interval. For reference purposes a study of modern pollen of Rubus chamaemorus L. and of 4 species of Drosera L. has been made. --Auth.

6. GEOPHYSICS

See also: Geologic Maps 1-2675 through 1-2678; Structural Geology 1-2738, 1-2741.

1-2795. Jacobs, J.A., R.D. Russell, and J. Tuzo Wilson. PHYSICS AND GEOLOGY: 424 p., illus., maps, New York, McGraw-Hill Book Company, Inc., 1959, 140 refs.

This book is an outgrowth of courses on the physics of the earth given by the authors over the past decade to senior undergraduates and graduate students in physics and in geology. As a consequence the book has 2 aims: 1) to give students of geology an introduction to the physics of the earth, 2) to give scientists in other fields some knowledge of geology and its relation to geophysics.

In the author's view the earth should be regarded as an active body, the physiology as well as the anatomy of which can be studied. In the past, geology has been chiefly concerned with describing the part of the earth's surface exposed above the sea and with tracing the earth's later history as indexed by fossils. Methods developed and applied during the past few years, however, have made it possible to describe the whole earth, from its deep interior to its outer atmosphere. Its development has been put into better perspective on an absolute time scale, and it has been possible to suggest the physical nature and causes of some of its processes. --J. A. Jacobs.

Contents: Universe and the solar system; seismology and the interior of the earth; composition of the earth; figure of the earth and gravity; thermal history of the earth; geomagnetism; physics of the upper atmosphere; geochronology; isotope geology; mechanical behavior of earth materials; investigation of the ocean floors; the ocean floors; the mid-ocean ridges; island arcs and mountains; inactive mountains and continents; origin of the earth's surface features; glaciology.

Appendices: Derivation of velocity-depth curves from travel-time tables; Clairaut's theorem; motion of single charged particle in earth's magnetic field; isotopic equilibria; dynamics of faulting; crevasses and crevasse patterns.

1-2796. ANNALS OF THE INTERNATIONAL GEOPHYSICAL YEAR: v. 2A, 395 p.; v. 3, pt. 1, 2/4, 381 p.; v. 4, pt. 1/3, 4/7, 393 p.; v. 5, pt. 1/3, 4/6, 468 p.; v. 6, pt. 1/5, 508 p.; v. 7, pt. 1/3, 388 p.; v. 8, 304 p., London, New York, Pergamon Press, 1957-1959.

Observations made during the International Geophysical Year, July 1, 1957 to Dec. 31, 1958, will be collected and made available to all nations at selected world centers. A large part of the observations and their discussion will be published in current periodicals and special volumes. The central record of the IGY, however, is to appear in a connected series of Annals [of which V. 3 was first to appear]. Their aim is to inform present-day readers and to aid the leaders of future still-greater enterprises. They will indicate the inception, planning, preparations, programs, and, in due course, the progress and some of the main results of the International Geophysical Year. --From foreword by S. Chapman (v. 3, p. vii).

Volumes published to date include the following. As they are not primarily concerned with solid earth geophysics, titles only are listed.

V. 2A. The International Geophysical Year Meetings.

V. 3. IGY Instruction Manual. The Ionosphere.
- Pt. 1. Ionospheric Vertical Soundings.
- Pt. 2. The Measurement of Ionospheric Absorption.
- Pt. 3. The Measurement of Ionospheric Drifts.
- Pt. 4. Miscellaneous Radio Measurements.

V. 4. IGY Instruction Manual.
- Pt. 1. Nuclear Radiation. Techniques for Radioactivity Measurements.
- Pt. 2. Aurora and Airglow.
- Pt. 3. Longitudes and Latitudes.
- Pt. 4 and 5. Geomagnetism.
- Pt. 6. Seismology.
- Pt. 7. Cosmic Radiation.

V. 5. IGY Instruction Manual.
- Pt. 1. Ozone.
- Pt. 2. Aurora and Airglow. Auroral Photography by All-Sky Camera.
- Pt. 3. Antarctic Radio Communication Manual, rev. ed. Aug. 1957.
- Pt. 4. Solar Activity.
- Pt. 5. Nuclear Radiation Pt. 2. Radioactive Fall-Out Data and Their Interpretation.
- Pt. 6. Radiation Instruments and Measurements.

V. 6. Manual on Rockets and Satellites.
- Pt. 1. Introduction.
- Pt. 2. The IGY Rocket Program.
- Pt. 3. The IGY Earth Satellite Program.
- Pt. 4. CSAGI Conference Resolutions and Data Guide.
- Pt. 5. Special Bibliography.

V. 7. IGY Instruction Manuals.
- Pt. 1. Manual on World Days and Communications.
- Pt. 2. CSAGI Guide to IGY Data Centers.
- Pt. 3. Arctic Communications.

V. 8. IGY Instruction Manuals. Geographical Distribution of the International Geophysical Year Stations.

1-2797. Carey, S. Warren. NORTH-SOUTH ASYMMETRY OF THE EARTH'S FIGURE [With comment by John A. O'Keefe]: Science, v. 130, no. 3381, p. 978-979, 2 figs., Oct. 16, 1959, 11 refs.

Evidence from satellite periodic variation that the earth is pear-shaped can alternatively be explained by assuming that the mean density of the mantle in the Southern Hemisphere is a little less than that in the Northern. This too is consistent with the hypothesis that the earth has been expanding rather than contracting since the Precambrian. Alpine structure can be explained, by analogy with glacial flow lines.

Comment by J. A. O'Keefe notes that the possibility of the mantle differing in density in the 2 hemispheres is not consistent with accepted hypotheses of fluid equilibrium. --M. Russell.

1-2798. Worzel, J. Lamar. CONTINUOUS GRAVITY MEASUREMENTS ON A SURFACE SHIP WITH THE GRAF SEA GRAVIMETER: Jour. Geophys. Research, v. 64, no. 9, p. 1299-1315, 16 figs. incl. charts, graphs, profiles, 2 tables, Sept. 1959, 17 refs.

Gravity measurements were made aboard the surface vessel U. S. S. Compass Island (EAG 153) with the Graf sea gravimeter mounted on a stabilized platform. Repeated observations along a line of gravity measurements previously made in submarines showed discrepancies of the order of the navigational variations. Many additional measurements agree satisfactorily with nearby previous submarine measurements.

It was demonstrated that the swell is the principal limitation to the measurements on Compass Island. When the vertical heave becomes too large, the boom of the instrument strikes the walls of its case, making observations impossible. On a 5-week cruise to the Mediterranean during March and Apr. 1958, observations were made 50% of the time in the Atlantic and 90% of the time in the Mediterranean.

The problem of measuring the Eötvös correction is more severe on a surface ship than on a submarine because of the larger effects from winds and currents to which the surface ship is subjected. This problem and the problem of locating the observation lines are the most serious difficulties encountered in making gravity measurements at sea.

The value of continuous gravity observations is demonstrated by examples of anomalies observed over seamounts, across the Mid-Atlantic Ridge, over the Canary basin, in the Tyrrhenian Sea, and through the Strait of Gibralter. Continuous observations reduce the chance of computational errors, prevent overlooking unanticipated features, provide a more representative gravity anomaly for an area, and provide more definitive data for the curve fitting that is required for geological interpretation of anomalies.

The Graf sea gravimeter in conjunction with a stable platform initiates a new era in the measurement of gravity at sea. Areas which are too hazardous for submarine observations can now be readily investigated. --Auth.

1-2799. Mokhova, E. N. A RECTANGULAR PRISM OF CONSTANT SUSCEPTIBILITY IN A HOMOGENEOUS MAGNETIC FIELD: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 216-218, diag., 3 graphs, March 1958, pub. July 1959, 4 refs.

This paper presents the results of a study of the distribution of induced magnetization and the structure of the magnetic field of rectangular prisms in the earth's field. The specimens used were mainly cubic, made of powdered titanomagnetite mixed with glue or plastic to give magnetic susceptibilities of 0.07 and 0.03 c. g. s. units, respectively. The magnetic field over the specimens was measured by a Kalachnikov field meter. A coil 3 x 3 x 3 mm. was used. The frequency of the field was 23 cycles per sec. The horizontal component of the geomagnetic field was compensated by Helmholtz coils. The field of a magnetized body having constant susceptibility was computed theoretically and compared with the experimental results. The experimental curve agrees rather well with the theoretical curve computed on the assumption of homogeneous magnetization, although at each end the experimental curve is flatter. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-290).

1-2800. Ovchinnikov, I. K. THEORY OF SINGLE ELECTRODE LOGGING: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 205-206, diag., March 1958, pub. July 1959, 6 refs.

Single electrode well logging is used for detecting a conducting (ore-bearing) layer in a drill hole, missed during the drilling because of nonrecovery of the core or other cause. The arrangement described consists of a metal ring sunk into the hole to the desired depth and touching its walls. The potential of the grounded ring in a homogeneous infinite medium (here the mud) can be represented in terms of a cylindrical function of an imaginary argument of zero order of the second type. Applying to this function the theorem of the summation of cylindrical functions and integrating, the value of the potential for the surface of the ring is obtained; dividing this value by the current, the transient resistance of the formation can be obtained for the general case as well as for the case when the surrounding rock has infinite resistivity so that current can flow only in the hole. A table of numerical values to facilitate the computations is presented. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-135).

1-2801. Barsukov, O. M. CHOICE OF A METHOD OF MEASUREMENT OF AN ALTERNATING ELECTRO-MAGNETIC FIELD: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 202-204, 3 figs. incl. graph, 2 tables, March 1958, pub. July 1959, 6 refs.

A method is given for computing the field produced by an infinite cable or equivalent ungrounded loop for the case when the surveyed area contains different bodies producing anomalies. A physical picture of the distribution of the electromagnetic field over the terrestrial surface and an approximate interpretation can be obtained only if a sufficient number of parameters sensitive to the changes of the field are considered. As always in the case of an alternating electromagnetic field, both electrical and magnetic characteristics must be analyzed. Tables are given of the ratio of major and minor axes of the ellipse of polarization and the angle between these axes for different geologic conditions. In addition the shortest distance between the electrodes necessary to produce a field approximating that of an infinite cable is given. The inclination of the ellipse of polarization is independent of the intensity of the current in the cable; this angle can be measured precisely by a single frame attachment. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-118).

1-2802. Khalfin, L.A. RADIO LOCATION METHOD OF SIGNAL ACCUMULATION AND TIMING IN GEOPHYSICAL PROSPECTING: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 207-210, diag., 2 graphs, March 1958, pub. July 1959, 5 refs.

Radio-wave surveying offers great possibilities for reconnaissance work if the signal-to-noise ratio can be increased substantially. The accumulation method recently used in sending signals to the moon offers such a possibility. This paper presents a detailed analysis of the method. The effect of interference on reception of the signals is discussed, applying the theory of probability and assuming that disturbances occur at random and have no relation to the periodicity of the radio signals. It is concluded that modern radio methods are capable of overcoming existing difficulties and should play an important role in geophysical investigations in the near future. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-123).

1-2803. McCrossan, Robert George. RESISTIVITY MAPPING OF THE SUBSURFACE UPPER DEVONIAN INTER-REEF IRETON FORMATION OF ALBERTA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 6, p. 121-130, 3 maps, 2 secs., 3 graphs, June 1959.

The Woodbend group of Upper Devonian age in central Alberta includes a reef complex characterized by large scale facies changes. The reefs, which grew in a subsiding basin and were initiated in restricted areas of suitable water depth, are surrounded by the calcareous shales and argillaceous limestones of the Duvernay and Ireton formations. A correlation section indicates depositional slopes of several feet per mile to the W. for these inter-reef beds. Very fine carbonate clastics derived from the reefs were spread throughout the basin during the Duvernay and lower Ireton time. The distribution of these carbonates is detected by mapping the average apparent resistivity of a given stratigraphic interval.

The pore volume of these rocks decreases with increasing depth of burial and lime content, and resistivity increases correspondingly. A straight-line relationship of lime content and porosity suggest that reduction of porosity is directly proportional to the volume of lime grains present. Resistivity, however, increases exponentially with a decrease in porosity or an increase in lime content. Other factors affecting porosity aside from lime content and depth of burial are small by comparison. Internal redeposition of lime has been unimportant.

Resistivity mapping in the subsurface shows promise of being a useful exploration tool for determining the relative amount of coarser grains in shale, and hence in predicting the direction to reef or shoal areas. --Auth.

1-2804. Keller, George V. DIRECTIONAL-RESISTIVITY MEASUREMENTS IN EXPLORATION FOR URANIUM DEPOSITS ON THE COLORADO PLATEAU: U.S. Geol. Survey, Bull. 1083-B, p. 37-72, 20 figs. incl. maps, diags., graphs, 5 tables, 1959, 5 refs.

A study of the electrical properties of the Morrison formation in the Uravan mineral belt of the Colorado Plateau province indicated that there is a significant correlation between electrical resistivity and the relative favorability for occurrence of ore. The differences in resistivity were not large enough to provide a recognizable target for standard resistivity field methods, especially where the ore-bearing sandstone member is more than a few hundred feet deep. Measurement of resistivity trends by placing one electrode in a drill hole and spreading the others out radially on the surface seemed to offer a means of exploiting the resistivity-favorability correlation.

Field tests of such directional-resistivity measurements were made in the Spud Patch area in San Miguel County, Colorado, and the White Canyon district, San Juan County, Utah. In the Spud Patch area 2 methods were tried; in one a current electrode was placed in the drill hole, and in the other a potential electrode. The second method was the more tedious but provided the more readily interpretable results. A comparison of the resistivity trends thus determined with the favorability estimated from geologic indexes indicated that directional-resistivity methods could predict the location of favorable areas at distances of 600-1,000 ft. with a high degree of success.

In the White Canyon district directional-resistivity measurements were made on the assumption that the conglomerate which is found in many channels filled with the Shinarump member of the Chinle formation has a high resistivity. The measurements were successful in tracing the channel conglomerate where surface conditions were favorable. --Auth.

1-2805. Keller, George V. ELECTRICAL PROPERTIES OF SANDSTONES OF THE MORRISON FORMATION: U.S. Geol. Survey, Bull. 1052-J, p. 307-344, 2 maps, 4 diags., 14 graphs (6 in pocket), 7 logs (in pocket), 3 tables, 1959, 8 refs.

The electrical properties of the Morrison formation [Jurassic] in the Uravan mineral belt of the Colorado Plateau have been studied to determine whether there are anomalous variations in these properties in and near zones of U-V minerals which might serve as a target for geophysical prospecting. Measurements of electrical properties of the Morrison formation in place were obtained by the electric logging of 147 drill holes, and measurements were made of the resistivity and porosity of 440 drill cores in the laboratory to aid in the interpretation of the electric logs. The resistivity of the sandstone members of the Morrison formation is highest in areas that are the most favorable for the occurrence of ore. This increase in resistivity is probably due to a lower water saturation or a lower salinity of the water in the favorable areas. --Auth.

1-2806. Duwalo, George and J. A. Jacobs. EFFECTS OF A LIQUID CORE ON THE PROPAGATION OF SEISMIC WAVES: Can. Jour. Physics, v. 37, no. 2, p. 109-128, 5 figs., Feb. 1959, 6 refs.

Effects of a spherical cavity in an infinite, homogeneous, isotropic elastic solid, containing nonviscous compressible liquid, on the propagation of elastic waves are investigated mathematically. The waves emitted by a simple harmonic point source in the solid are of the types known as SH and P in seismology. The discussion is restricted to the case $ka \gg 1$ ($ka = 2\pi$ cavity radius/wave length). Series solutions are transformed into contour integrals by Watson's method. Evaluation of these by the method of residues results in expressions describing the P and S components of the diffracted waves. --Auth.

1-2807. Shamina, O.G., and O.I. Silaeva. THE PROPAGATION OF ELASTIC PULSES IN FREE BOUNDARY LAYERS OF FINITE THICKNESS: Akad.

Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 168-174, 5 graphs, 3 seismograms, March 1958, pub. July 1959, 19 refs.

This paper describes experiments concerning the propagation of elastic pulses in free boundary layers of finite thickness. The experiments are based on the ultrasonic pulse method and the technique of longitudinal profiling. It was found that longitudinal waves are able to traverse a layer at 2 different veolocities only: one equivalent to the velocity of the longitudinal waves in the body, and the other equivalent to the velocity of a longitudinal wave in an infinitely thin plate. The wave pattern and the predominant wave length are related to the thickness of the layer. The experimental results were compared with theoretical calculations. The conclusions may be important for the study of the dynamics of propagation of seismic waves in layered media (seismology, seismic prospecting). --Auth.

1-2808. Yanovskaya, T.B. ON THE DETERMINATION OF THE DYNAMIC PARAMETERS OF THE FOCUS HYPOCENTER OF AN EARTHQUAKE FROM RECORDS OF SURFACE WAVES. I: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 161-167, 11 graphs, March 1958, pub. July 1959, 4 refs.

Using the Keylis-Borok method, Yanovskaya determines the amplitudes of the Rayleigh and Love waves propagating in a layer overlying an elastic semispace. The waves are produced by a steady concentrated source within the stratum, consisting of a dipole with moment. The paper is purely mathematical. The formulas obtained as well as the results of observations will be discussed in the second part of the study. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-51).

1-2809. Witkind, Irving J. THE HEBGEN LAKE EARTHQUAKE: GeoTimes, v. 4, no. 3, p. 13-14, illus., maps, Oct. 1959.

The surface effects of the earthquake in Montana of Aug. 17 and 18, 1959, were centered about Hebgen Lake, and the name Hebgen Lake earthquake is proposed. The first and most severe shock occurred about 11:40 p. m., Aug. 17, and lasted somewhere between 10 sec. and 1 min. The geologic effects include new faults, tilting of the floor of Hebgen Lake, landslides and changes in water occurrence. Fault scarps as high as 20 ft., fissures as deep as 10 ft., and sand and gravel boils 50 ft. long, 20 ft. wide, and 12 ft. deep were formed. --M. Russell.

1-2810. Hadley, Jarvis B. THE MADISON CANYON LANDSLIDE: GeoTimes, v. 4, no. 3, p. 14-17, illus., maps, Oct. 1959.

The most dramatic and disastrous effect of the Hebgen Lake earthquake was a great landslide in the canyon of the Madison River 6 mi. below Hebgen Dam. Thirty-five million cubic yards of broken rock slid into the canyon in less than a minute, covering the river and highway for nearly a mile to a depth of 100 to 300 ft. Water impounded by the slide formed a lake which, 3 weeks later, was 175 ft. deep. The slide occurred 5 mi. from the nearest fault involved in the earthquake. A wedge of resistant dolomite at the base of the preslide mass was weakened by the earthquake and released a mass of deeply weathered schist and gneiss upslope which, but for the wedge of dolomite, would have previously moved downslope slowly through creep. --M. Russell.

1-2811. Sultanova, Z.Z. PROCESSING OF OBSERVATIONS FOR EARTHQUAKES OF AZERBAYDZHAN: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 224-228, 7 figs., 4 tables, March 1958, pub. July 1959, 11 refs.

Riznichenko's method of "time fields" for locating earthquake foci is applied to the Azerbaydzhan earthquakes of Oct. 27, 1952, Sept. 23, 1953, and Oct. 4, 1953. The method presupposes knowledge of the crustal structure and layer velocities of the region investigated. Foci are determined graphically. Sources of error in the method are analyzed. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-29).

1-2812. Khalevin, N.I. ON THE IMPULSE-INTERVAL ACOUSTICAL LOGGING: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 211-215, 4 figs. incl. diag., March 1958, pub. July 1959, 10 refs.

A description of a new method of well-logging, in which the strata pierced by the drill hole are identified from observation of the velocities of elastic waves produced in the drill hole; the thickness of individual strata is determined together with the exact position of relecting and refracting horizons. The apparatus consists of an elastic wave generator mounted in a hermetically sealed container, and a receiver at a fixed distance from the generator with an amplifier, a time recorder, and an oscillograph. The impulse which produces the shock in the wall of the container and reaches the walls of the drill hole is acted upon by an electromagnet controlled from the surface of the ground. Several waves of different velocities and frequencies were observed during tests in the sedimentary formations of the Chelyabinsk lignite fields, including the longitudinal, transverse, and Lamb waves. The recurrence of the same frequency spectrum was very good, so that the experiments could be repeated at different times. The spectrum of the waves produced was very much influenced by the elastic properties of the surrounding formations and the depth to which the probe was sunk. As a precaution against the short circuiting, the space between the transmitter and the receiver was filled with rubber. Numerous seismograms obtained during the experiments are reproduced and their geologic interpretation suggested. The most important advantage of the apparatus is the possibility of determining the characteristics of a much greater volume of rocks. It also decreases the effect of caverns or local heterogeneities. The nature of an unidentified elastic wave observed during the experiments is to be investigated in future tests. --S. T. Vesselowsky (courtesy Geophysical Abstracts 179-339).

1-2813. Vassilyev, Yu. I., O.I. Kovalev, and I.S. Parkhomenko. STUDY OF THE CRYSTALLINE BASEMENT BY THE REFRACTED WAVE METHOD UNDER CONDITONS OF PARTIAL MASKING: Akad. Nauk. SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 175-182, 14 figs. incl. diag., graphs, seismograms, March 1958, pub. July 1959, 10 refs.

It is known that the propagation of seismic waves through geological strata meets a resistance proportional to the ratio of thickness to wave length (d/λ). Therefore, a lower frequency than usual has been used for the transmission of seismic waves and a low frequency (15-35 cycles per sec.) modification of

the correlation refraction method has been worked out. Its application to the surveying of the crystalline basement in several areas under conditions of incomplete screening is described in this paper. A detailed analysis of the apparatus is presented, and seismogram results analyzed. These tests show that the use of low frequency equipment makes it possible to record longitudinal refracted waves corresponding to the surface of the basement even when this is covered with a thick layer of carbonate rocks having almost the same velocities, where use of medium-frequency equipment earlier had failed to give results. Essential differences between the waves refracted from intermediate layers in the carbonate complex and those refracted from the crystalline surface were found in the record form, frequency characteristics, and damping. The same equipment can be used also in studies of thick sedimentary rocks, especially in the case of strong absorption of seismic energy or in the presence of screening strata. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-332).

1-2814. Chetayev, D.N. DETERMINATION OF THE THERMAL COEFFICIENTS BY THE METHOD OF A LINEAR INSTANTANEOUS SOURCE: Akad. Nauk SSSR, Bull., Geophysics Ser., in translation, no. 3, p. 200-201, graph, March 1958, pub. July 1959, 3 refs.

The thermal coefficients of solid substances were determined by Dergunov's method, in which a narrow hole is drilled in a specimen or in the wall of a mine gallery, a current-carrying spiral is introduced into it for a measured interval of time, with a thermocouple in another similar hole. The thermal coefficients of the medium can be calculated from the measured amount of heat introduced, the highest temperature observed, and the time necessary for its attainment, based on the equation for the variation of temperature t of the medium produced by the action of a linear heat source of a constant intensity:

$$\frac{\delta^2 t}{\delta r^2} + \frac{1}{r}\frac{\delta t}{\delta r} = \frac{1}{a}\frac{\delta t}{\delta \tau},$$

where a is the temperature coefficient of the medium, t the temperature, τ the time; with known initial conditions the solution can be found as integral exponential function, and the numerical values of this function can then be obtained from 2 graphs given in the article. --S. T. Vesselowsky (courtesy Geophysical Abstracts 174-217).

1-2815. Grossling, B. F. TEMPERATURE VARIATIONS DUE TO THE FORMATION OF A GEOSYNCLINE: Geol. Soc. America, Bull., v. 70, no. 10, p. 1253-1281, 7 diags., 19 graphs, 3 tables, Oct. 1959, 20 refs.

The perturbation of the thermal equilibrium, produced by subsidence and sedimentation in the earth's outer layers is investigated by means of 2 models. In one the heat reaching the surface is assumed to come from the deep interior, in the other, to be generated in the crust.

The models consist of 3 horizontal layers, the top one representing the sedimentary layers, the middle one representing the crystalline part of the continental crust, and the lowest one representing the plastic substratum. It is assumed that at a particular instant the thickness of the top layer is increased. A theory is developed to determine the subsequent temperature variations. Also, asymptotic values are found for large times.

A finite subsidence velocity introduces an uncertainty in the time of origin of the rapid-subsidence model. For events which occur long after the subsidence, the instantaneous assumption is adequate. Moreover, it is adequate without this restriction in the lower part of the crust and in the substratum.

For large times, the deviation from the final steady state is a linear function of the depth. When the heat comes from the interior, the temperature deviation from the final steady state varies as $t^{-3/2}$, whereas when the heat is generated in the crust, it varies as $t^{-1/2}$.

The temperature variations are evaluated for subsidences of 6 and 13 km. The sedimentary layer is assumed to be 2 km. thick initially, and the crystalline crust is assumed to be 30 km. thick. The time variation of the different components of the temperature variations gives an insight into the propagation of thermal disturbance in the earth. Thermal adjustment requires millions of years.

After subsidence, the temperature increases rapidly during the first 20 million years or so. Thereafter, the rate of increase is much smaller. The increase is much more rapid in the sediments than in the lower part of the crust. At the base of the crust, the increase is about 22°-23°C. per km. of subsidence, if the thermal conductivity is 0.006 cgs. However, if the conductivity decrease with the temperature in the range of crustal temperatures was taken into consideration, much larger increases would be obtained.

The times required for thermal adjustment are large enough to be significant in certain geological processes. The temperature increase after subsidence should affect the rate of lithification of sediments and the strength of the crust.

Both the stresses and the temperature of a certain portion of sediment increase with subsidence. At depths greater than a few hundred feet, the confining stress on the grain matrix corresponds, practically without any time lag, to the current depth of burial. On the other hand, the adjustment of the temperature lags appreciably. Thus, lithification may be incomplete at certain depths because the temperature is still far below its final value. Lithification is likely to be completed within the first 20 million years after the subsidence.

During the folding stage of a geosyncline, the shearing rate of the crustal rocks increases appreciably. The crustal "solid viscosity" may decrease markedly when the temperature reaches the value it has at the base of an undisturbed crust. Thus, the crustal strength decreases relatively quickly up to about 20 million years after the subsidence and thereafter much more slowly. Because of this decrease, the folding stage of a geosyncline would occur 15-20 million years after the subsidence.

If heat comes from the deep interior, there is, for a certain time, a zone of cooling in the substratum. The corresponding increase in the solid viscosity of the substratum may effectively lock, for a certain time, the subsequent uplift of the crust. --Auth.

1-2816. Pearce, D.C., and L.W. Gold. OBSERVATIONS OF GROUND TEMPERATURE AND HEAT FLOW AT OTTAWA, CANADA: Jour. Geophys. Research, v. 64, no. 9, p. 1293-1298, 4 graphs, 2 tables, Sept. 1959, 5 refs.

Observations were made at a site in Ottawa, Canada, on the thermal regime of the ground and the heat flow 10 cm. below the ground surface. Close agreement was found between the thermal diffusivities calculated from the depth dependence of the tempera-

ture amplitude and the depth dependence of the phase angle. It was also found that the annual component of the rate of heat flow was out of phase with the annual component of the ground temperature by 45.8 degrees. These observations showed that for the Ottawa site the annual wave of ground temperature and the annual component of the rate of heat flow are consistent with the simple theory of periodic heat flow in a one-dimensional, semi-infinite, homogeneous medium. In accordance with this theory, thermal constants for the soil at the test site were calculated from the observations. --Auth.

1-2817. Lachenbruch, Arthur H. PERIODIC HEAT FLOW IN A STRATIFIED MEDIUM WITH APPLICATION TO PERMAFROST PROBLEMS: U.S. Geol. Survey, Bull. 1083-A, p. 1-36, 2 charts, diag., 8 graphs (3 in pocket), 3 tables, 1959, 6 refs.

Solutions to the Fourier heat equation for quasi-steady periodic flow in a stratified semi-infinite medium can be obtained readily by standard methods. The results have wide application to studies of earth-temperature variations induced by diurnal, annual, and other periodic variations in ground-surface temperature. Much of the previous work on this subject has been interpreted with reference to the solution for the homogeneous case; and this can be seriously in error when applied to stratified earth materials.

One application of the theory is to the important problem of determining the minimum thickness of gravel fill required to maintain the material on which it rests (the subgrade) in a perennially frozen state in permafrost areas. The results indicate that the required fill thickness is very sensitive to the thermal properties of the subgrade. If a thin layer of material with a low thermal contact coefficient, such as spruce logs, is placed between the fill and subgrade, the thickness of fill required to maintain undisturbed permafrost can be greatly reduced.

The thermal properties of the soil beneath the layer supporting plant growth can have an important influence on the temperatures in that layer. This effect, which cannot be explained by studies of the ground surface and the surficial layer, is likely to have important application to plant ecology in the arctic.

The theory yields an approximate method of estimating the effect of winter snow cover on the mean annual temperature of the ground surface. --Auth.

1-2818. Lachenbruch, Arthur H., and Max C. Brewer. DISSIPATION OF THE TEMPERATURE EFFECT OF DRILLING A WELL IN ARCTIC ALASKA: U.S. Geol. Survey, Bull. 1083-C, p. 73-109, 7 graphs, 8 tables, 1959, 13 refs.

Temperature measurements to a depth of 595 ft. were made during a period of 6 years after the drilling of a 2,900-ft. well near the Arctic coast at Barrow, Alaska. The temperature-time curves for depths from 295 to 595 ft. fit a simple 2-parameter logarithmic formula within instrumental error (+ 0.01°C.) for data taken during the last 4 1/2 years. This formula, which is of the type proposed by Bullard, is based upon a highly simplified theoretical model of the thermal history of the well. The general features of the temperature-time curves for earlier times can be explained in terms of the various physical factors neglected in the simplified model. The analysis indicates that the thermal disturbance decreased from about 20°C. to about 0.1°C. in the 6-year period following drilling. It is estimated that about 50 years will elapse between the time of drilling and the time the temperature disturbance caused by drilling diminished to 0.01°C. in the depth range studied.

This work probably forms an adequate basis for the study of secular changes in ground temperature that are measurable during the period of observation. Such changes have been observed at all depths from 75 to 275 ft. --Auth.

1-2819. Haites, T. Binnert. BANFF THERMAL SPRINGS, A FASCINATING PROBLEM: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 2, p. 23-32, map, sec., 2 tables, Feb. 1959, 22 refs.

Sundance Creek is thought to be the source for the water discharged by the thermal springs at Banff [Alberta, Canada]. The path of the water, its composition and heating are discussed, as well as the water cycle period and remedial measures to guarantee an uninterrupted flow. A post-glacial birthdate for the springs is suggested by the tufa deposits. --Auth.

7. GEOCHEMISTRY

See also: Stratigraphy 1-2769; Sedimentary Petrology 1-2856, 1-2857; Mineral Deposits 1-2888.

1-2820. Muan, Arnulf. STABILITY RELATIONS AMONG SOME MANGANESE MINERALS: Am. Mineralogist, v. 44, no. 9/10, p. 946-960, 6 diags., table, Sept.-Oct. 1959, 22 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. No. 58-36.

Stability relations among crystalline phases in the system manganese oxide-SiO_2 have been studied in atmospheres of controlled O_2 pressures ranging from $10^{-2.5}$ to 1 atm. and at temperatures ranging from 973 to 1206°C. The crystalline phases encountered in the present study are Mn_3O_4, braunite (Mn_2O_3 (SS)), tephroite ($2MnO \cdot SiO_2$), rhodonite ($MnO \cdot SiO_2$ (SS)), and tridymite (SiO_2). Equations are given relating O_2 partial pressures and temperatures for 6 different univariant situations characterized by the equilibrium coexistence of gas and 3 crystalline phases. --Auth.

1-2821. MacChesney, J.B., and Arnulf Muan. STUDIES IN THE SYSTEM IRON OXIDE-TITANIUM OXIDE: Am. Mineralogist, v. 44, no. 9/10, p. 926-945, 3 diags., graph, 3 tables, Sept.-Oct. 1959, 28 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. No. 58-39.

Phase equilibria in the system iron oxide-TiO_2 in air have been investigated at temperatures extending from the liquidus to slightly below the solidus. Stability relations among the phases spinel solid solution ($FeO \cdot Fe_2O_3$-$2FeO \cdot TiO_2$), hematite solid solution (Fe_2O_3-$FeO \cdot TiO_2$), pseudobrookite solid solution ($Fe_2O_3 \cdot TiO_2$-$FeO \cdot 2TiO_2$), rutile solid solution, liquid and gas are illustrated in an apparently binary diagram obtained by projecting ternary phase relations

in the system $FeO-Fe_2O_3-TiO_2$ into the join $FeO \cdot Fe_2O_3-TiO_2$. --Auth.

1-2822. Kramer, James R. CORRECTION OF SOME EARLIER DATA ON CALCITE AND DOLOMITE IN SEA WATER: Jour. Sed. Petrology, v. 29, no. 3, p. 465-467, 2 graphs, Sept. 1959, 3 refs.

Corrections are given for solubility products of calcite and dolomite (Geol. Soc. America, Bull., v. 60, no. 12, pt. 2, p. 1600, 1958, abstract). For calcite at 25°C., the figures are 0.65×10^{-6}, 1.40×10^{-6}, and 1.8×10^{-6} for 35, 45, and 60‰ salinity sea water, and for dolomite at 25°C., 2.95×10^{-13}, 1.38×10^{-12}, and 2.04×10^{-12} for 35, 45, and 60‰ salinity. The equilibrium of calcite and dolomite in sea water a) as a function of salinity and carbonate ion concentration; and b) as a function of salinity and pH together with dolomite stability and calcite instability, are given in a figure. --D. Carroll.

1-2823. Sen, Sisir K. POTASSIUM CONTENT OF NATURAL PLAGIOCLASES AND THE ORIGIN OF ANTIPERTHITES: Jour. Geology, v. 67, no. 5, p. 479-495, 3 illus., diag., 3 graphs, 10 tables, Sept. 1959, 32 refs.

The K content of the natural plagioclases has been investigated. Plagioclases from amphibolite facies, granulite facies, and volcanic rocks were chemically analyzed for K. A definite trend of increasing K content with increasing temperature of formation has been found. The following effects are considered by way of explanation: 1)increasing "openness" of plagioclase structure, 2) strengthening of Si-O bonds by accepting K, and 3) facilitated co-ordination of K by O with increasing Al-Si disorder in plagioclase. The antiperthitic plagioclases occurring in relatively high-temperature rocks (granulite facies, volcanic, contact metamorphic) have been interpreted as products of excolution. Antiperthites of replacement origin have also been recognized. --Auth.

1-2824. Newman, William L., and Donald P. Elston. DISTRIBUTION OF CHEMICAL ELEMENTS IN THE SALT WASH MEMBER OF THE MORRISON FORMATION, JO DANDY AREA, MONTROSE COUNTY, COLORADO: U.S. Geol. Survey, Bull. 1084-E, p. 117-150, 2 maps, diags., 3 tables, 1959, 8 refs.

A study of the distribution of the chemical elements in samples from the Salt Wash member of the Morrison formation of Late Jurassic age in the Jo Dandy area, Montrose County, Colorado, was made to determine average chemical compositions of mudstone and sandstone and to determine the magnitude of variations in the concentrations of elements within similar rock types. Analytical data were obtained by semiquantitative spectrographic and radiometric methods.

Results of the study show that variations in concentrations of about 20 elements commonly detected by semiquantitative spectrographic analyses of sedimentary rocks are small for a specific rock type; therefore, considerable confidence may be placed upon the average chemical composition derived from the sample populations. In addition, there appears to be no significant relation between the chemical composition of mudstone or sandstone and the distance from known U-V ore or mineralized rock.

Mudstone generally contains greater concentrations of the elements studied than sandstone. The chemical composition of red mudstone is similar to the chemical composition of green mudstone except that red mudstone was found to contain almost twice as much Ca as green mudstone in the Jo Dandy area.

Samples of unoxidized sandstone from the Jo Dandy area contain about twice as much Ca, three times as much Sr, but only about one-half as much Zr as oxidized sandstone; except for these elements the chemical compositions of both categories of sandstone are similar. Samples of sandstone of the Salt Wash member in the Jo Dandy area contain more K, Mg, V, and Ni than "average" sandstone of the Salt Wash member.

The distribution of Bi in rocks of the Jo Dandy area suggests that Bi and perhaps part of the K and Mg found in rocks of the Salt Wash member were derived either from solutions which ascended from the underlying salt- and gypsum-bearing Paradox member of the Hermosa formation or were contained in gypsiferous material of the Paradox member that was incorporated with rocks of the Salt Wash during sedimentation. --Auth.

1-2825. Sheldon, Richard P. GEOCHEMISTRY OF URANIUM IN PHOSPHORITES AND BLACK SHALES OF THE PHOSPHORIA FORMATION: U.S. Geol. Survey, Bull. 1084-D, p. 83-115, chart, 10 diags., 6 tables, 1959, 34 refs.

U in the Phosphoria formation of Permian age in the western phosphate field occurs mostly in phosphorite and partly in black shale. However, some of the phosphorites and most of the black shales of the formation are practically nonuraniferous. These anomalies in U content can be related to the petrography and composition of the rocks.

A basic premise to this study is that the immediate source of the U in the Phosphoria formation was the ocean. The facts that the quantity of U in the formation is large and widely distributed and that comparable Recent marine phosphorites are uraniferous support this premise. The chemistry of U in the ocean has been little studied, but several deductions can be made from the known thermodynamic data and the chemical data of U in aqueous solutions. Garrels has shown that the pH and the Eh control the oxidation state of U in natural water, and a survey of the literature reveals that the increasing pH favors the formation of complex ions made up of a uranyl ion and anions present in the sea, such as PO_4^{-3}, CO_3^{-2}, OH^-, and SO_4^{-2}. The formation of uranyl sulfate complexes is favored by high Eh.

The phosphatic rocks of the formation are classified according to the Eh and pH of their depositional environment, and their U contents are compared by means of a distribution-free statistical test. This analysis shows that the phosphatic sediments that were deposited in an environment of low Eh are relatively rich in U, whereas phosphatic sediments deposited in an environment of high Eh are relatively poor in U. The pH of the environment where apatite is stable apparently has no effect on the concentration of U. Two hypotheses for the occurrence of U in apatite are reviewed: a) the substitution of U (IV) for Ca in the apatite lattice, and b) the adsorption of the uranyl ion on the surfaces of apatite crystallites. No clear-cut choice between these 2 modes of occurrence can be made with the present data, as both U (IV) and U (VI) are known to occur in the Phosphoria formation. Multiple regression analyses show that U is positively correlated with both P_2O_5 and Fl present in the apatite in quantities exceeding that of lattice requirements. This correlation seems to be best explained by adsorption of both excess Fl and

U on the surfaces of apatite crystallites. The size of apatite crystallites was investigated by X-ray diffraction techniques; the results suggest, but do not prove, that apatite rich in excess Fl and U is made up of the smallest crystals.

These data suggest that U is probably deposited in apatite in one or both of 2 ways:

1. Low Eh of the depositional environment causes the highest concentration of the U^{+4} ion and thereby more U (IV) is substituted for Ca in the apatite lattice; or

2. A low Eh of the depositional environment allows the accumulation of organic matter, which inhibits growth of apatite crystallites, allowing more uranyl ion to be adsorbed on crystallite surfaces.

Few data are available on the mode of occurrence of U in black shale, but, from chemical and stratigraphic considerations, it seems possible that the U is deposited as disseminated UO_2 in a reducing acid depositional environment. --Auth.

1-2826. Schleicher, John A. GERMANIUM IN KANSAS COALS: Kansas, State Geol. Survey, Bull. 134, pt. 4, p. 161-179, map, graph, 2 tables, 1959, 18 refs.

A detailed spectographic method for determining the Ge content of coal is described and the results of analyses of 20 Kansas coals from 117 different locations are reported. No definite conclusions are made as to geographic or stratigraphic variation in Ge content. The concentration of Ge in the coal ash ranges from .0018% to .0575 %, and in the total coal from .0006% to .0116%. --Auth.

1-2827. Roy, Rustum, A.J. Majumdar, and C.W. Hulbe. THE Ag_2S AND Ag_2Se TRANSITIONS AS GEOLOGIC THERMOMETERS: Econ. Geology, v. 54, no. 7, p. 1278-1280, 2 tables, Nov. 1959, 6 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. 58-99.

The pressure dependence of the argentite-acanthite (Ag_2S) and high-low naumannite (Ag_2Se) transitions has been studied beyond 1,000 atm. The inversion temperatures, 176°C. and 128°C. are both raised less than 10°C. by an increase of pressure of 1,000 atm. The usefulness of the presence of argentite and of high-naumannite as indicators of certain minimum temperatures is therefore enhanced, especially in analyzed samples. --Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Sedimentary Petrology 1-2870.

1-2828. Berry, L.G., and Brian Mason. MINERALOGY: CONCEPTS, DESCRIPTIONS, DETERMINATIONS: 612 p., illus., diags., tables, San Francisco, W.H. Freeman and Company, 1959, approx. 50 refs.

The book is designed for the undergraduate course in mineralogy. Emphasis is given to general principles and the significance of mineralogical data in interpreting geological phenomena, especially in petrology and economic geology. Special emphasis is given certain aspects of the subject as they bear on the chemical and physical conditions that existed at the time of mineral formation. The consideration of minerals as crystalline solids involves giving attention to both external form and internal structure and to their interdependence. The chemistry of minerals is regarded as a specialized part of solid state chemistry, requiring consideration of the relative sizes of atoms, the types of bonding, and the significance of these bonds in determining crystal structure. This leads to discussions of isomorphism, atomic substitution, and polymorphism in minerals. In the treatment of the physics of minerals, emphasis is on the interrelations of physical properties, crystal structure, and chemical composition. The chapter on genesis goes beyond the occurrence and associations of minerals to a consideration of their origin, the emphasis here being on the correlation of geological observations with physicochemical principles and experimental data.

In Pt. 2 of the book are described some 200 minerals in detail; many others are mentioned incidentally. Pt. 3 consists of determinative tables to provide the student with a scheme for the examination of unknown specimens and their identification. --From auth. pref.

1-2829. Gordon, Robert B. COLOR CENTERS IN CRYSTALS: Am. Scientist, v. 47, no. 3, p. 361-375, 4 illus., 6 diags., 3 graphs, Sept. 1959.

Displays of color in normally transparent crystals may be due to imperfections in the crystal, plasticity of crystals, especially those of metals, transistor action, and catalytic power. Small amounts of chemical impurities may also produce color. Many transparent crystals can be colored by physical treatment in the laboratory. Coloration from radiation was first observed in 1830. F-centers in rocksalt and some applications of this knowledge of color center phenomena are discussed. The most important cause of radiation coloring in minerals is the radiation of naturally radioactive elements concentrated in areas of mineralization. In some minerals the color bleaches out when exposed to daylight; however, many minerals show permanent radiation coloration. These natural specimens often display complex, absorption spectra with bands due to complex color centers and to colloidal particles formed during prolonged irradiation. Although there are still many unsolved problems, much progress has been made in the past 15 years. This advance is felt to be due largely to cooperation among scientists in different fields. --L. M. Dane.

1-2830. Mandarino, Joseph A. REFRACTION, ABSORPTION AND BIABSORPTION IN SYNTHETIC RUBY: Am. Mineralogist, v. 44, no. 9/10, p. 961-973, 6 graphs, 7 tables, Sept.-Oct. 1959, 9 refs.; also pub. as: Michigan, Univ., Dept. Mineralogy, Contr. No. 234.

Refractive indices, absorption coefficients, and biabsorption were determined for 2 synthetic ruby samples, one colored pink by 0.11% Cr_2O_3 and the other colored deep red by 1.40% Cr_2O_3.

The refractive indices of the pink sample vary from n_ω = 1.7761 and n_ϵ = 1.7677 at 480 m_μ to n_ω = 1.7635 and n_ϵ = 1.7554 at 700 m_μ. For the red sample, n_ω and n_ϵ vary from 1.7821 and 1.7741, respectively, to 1.7696 and 1.7614 for the same spectral region.

The maximum value of the absorption coefficient for the ordinary ray occurs at 560 mμ for both samples, while the maximum value for the extraordinary ray in both samples occurs at 550 mμ. Values of the absorption coefficients at the peak wave lengths are: $k_\omega = 34.9 \times 10^{-6}$, $k_\epsilon = 25.4 \times 10^{-6}$ (for the pink ruby) and $k_\omega = 311.0 \times 10^{-6}$, $k_\epsilon = 138.2 \times 10^{-6}$ (for the red ruby). The maximum negative ($k_\epsilon < k_\omega$) value of biabsorption for both samples occurs at 570 mμ. These biabsorption values calculated from the absorption coefficients are -10.4×10^{-6} and -184.1×10^{-6} for pink and red ruby, respectively. Those obtained by the visual-matching method are -10.0×10^{-6} and -193.0×10^{-6}. --Auth.

1-2831. Smith, Deane K. AN X-RAY CRYSTALLOGRAPHIC STUDY OF SCHROECKINGERITE AND ITS DEHYDRATION PRODUCT: Am. Mineralogist, v. 44, no. 9/10, p. 1020-1025, 4 tables, Sept.-Oct. 1959, 3 refs.

X-ray precession patterns of schroeckingerite crystals from Moab, Utah, show that the mineral has triclinic pseudo-hexagonal symmetry. Dimensions of the unit cell containing $2(NaCa_3UO_2(CO_3)_3SO_4F \cdot 10H_2O)$ are $a = 9.60 \pm 0.01$ Å, $b = 9.62 \pm 0.01$ Å, $c = 14.46 \pm 0.01$ Å, $\alpha = 91^\circ 42' \pm 10'$, $\beta = 91^\circ 48' \pm 10'$, and $\gamma = 120^\circ 05' \pm 10'$. The space group is $P\bar{1}$ or P 1. When the material is dried at 75°C., it loses 6 of the 10 water molecules. The unit cell of the product has $a = b = 9.52 \pm 0.02$ Å, $c = 11.10 \pm 0.02$ Å, $\alpha = 95 \pm 5^\circ$, $\beta = 93 \pm 5^\circ$ and $\gamma = 60^\circ 00' \pm 15'$, and its space group is also $P\bar{1}$ or P1 with $Z = 2$. --Auth.

1-2832. Kamhi, Samuel R. AN X-RAY STUDY OF UMOHOITE: Am. Mineralogist, v. 44, no. 9/10, p. 920-925, illus., 2 graphs, 2 tables, Sept.-Oct. 1959, 4 refs.

Precession photographs of umohoite from Marysvale, Utah, indicate a primitive orthorhombic unit cell with dimensions $a_0 = 6.32$ Å; $b_0 = 7.48$ Å; $c_0 = 12.4$ and 14.5-17.0 Å. The range of c_0 with humidity and with temperature is established. X-ray powder data for umohoite with $c_0 = 12.4$ Å are listed and indices have been assigned on the basis of the cell dimensions given. Powder data are also furnished for material with $c_0 = 14.5$ Å. --Auth.

1-2833. Frueh, Alfred J., Jr. THE USE OF ZONE THEORY IN PROBLEMS OF SULFIDE MINERALOGY, PART II; THE RESISTIVITY OF CHALCOPYRITE: Am. Mineralogist, v. 44, no. 9/10, p. 1010-1019, illus., chart, diag., 2 graphs, Sept.-Oct. 1959, 13 refs.

Resistivity vs. temperature measurements on chalcopyrite indicate a very small activation energy for donor impurities. In a S-free atmosphere dissociation occurs at a lower level of thermal energy than does intrinsic semiconductivity, suggesting a relatively large energy gap between the valence and conduction bands. Attempts to maintain equilibrium S vapor pressure during resistivity measurements in order to obtain the exact band gap energy were unsuccessful. Total absence of p-type conductivity was noted. This implies that chalcopyrite will not occur with a cation deficiency, but will deviate from stoichiometry only with a cation excess. --Auth.

1-2834. Birks, L.S., E.J. Brooks, Isidore Adler, and Charles Milton. ELECTRON PROBE ANALYSIS OF MINUTE INCLUSIONS OF A COPPER-IRON MINERAL: Am. Mineralogist, v. 44, no. 9/10, p. 974-978, 2 illus., table, Sept.-Oct. 1959, 10 refs.

An application of the electron probe X-ray microanalyzer to the analysis of extremely minute inclusions in minerals is described. Strongly birefringent grains about 0.03 mm. in size, which resemble what has been termed valleriite, occur in chalcopyrite from the Mackinaw mine, Snohomish County, Washington. These grains were found by the electron probe analysis method to contain about 55% Fe and less than 5% Cu; the composition was inferred to be approximately FeS. These results suggest that the mineral previously generally termed valleriite in high-temperature Cu ores is distinct from the type of valleriite from Kaveltorp, Sweden, and is probably an undescribed sulfide. --Auth.

1-2835. Jenness, Stuart E. "MAGNETIC" CHROMITE FROM SHOAL POND, NORTHEASTERN NEWFOUNDLAND: Econ. Geology, v. 54, no. 7, p. 1298-1301, 2 illus., map, Nov. 1959, 7 refs.

The magnetic property of the chromite at Shoal Pond, Newfoundland, is not inherent to the chromite, as formerly reported, but is caused by the presence of many tiny intersecting veinlets of magnetite within some of the chromite grains. Somewhat similar textures have been reported in Europe, but only one similar phenomenon has been described in North America. --Auth.

1-2836. Karkhanavala, M.D. THE NATURE OF ARIZONITE: Econ. Geology, v. 54, no. 7, p. 1302-1308, 4 tables, Nov. 1959, 14 refs.

The evidence for discrediting the mineral is analyzed to show that the natural mineral cannot be regarded as a mere mixture of hematite, anatase, rutile and possibly ilmenite. Also it cannot be regarded as simply weathered ilmenite, though it may possibly be an alteration product of ilmenite formed under hydrothermal or metasomatic conditions. It is concluded that the mineral arizonite represents a specific and unique, though somewhat rare and unstable chemical compound. This is also supported from the author's separate work in the system Fe_2O_3-TiO_2. --Auth.

1-2837. Sherman, G. Donald, and Haruyoshi Ikawa. OCCURRENCE OF GIBBSITE AMYGDULES IN HAIKU BAUXITE AREA OF MAUI: Pacific Sci., v. 13, no. 3, p. 291-294, illus., graph, table, July 1959, 5 refs.; also pub. as: Hawaii, Agr. Expt. Sta., Tech. Paper no. 400.

The amygdules are formed by the rhythmic precipitation of hydrated aluminum oxide in cavities which are relics of the parent rock. These cavities were probably gas bubbles in the original lava. The amygdules contain approximately 62% Al_2O_3, 6% Fe_2O_3, and trace amounts of silica and titania. The hydrated aluminum oxide has been identified as gibbsite by differential thermal analysis. --From auth. summ.

1-2838. Medlin, W.L. THE PREPARATION OF SYNTHETIC DOLOMITE: Am. Mineralogist, v. 44, no. 9/10, p. 979-986, illus., table, Sept.-Oct. 1959, 8 refs.

Synthetic dolomite has been formed by precipitation from a solution of $MgCl_2$, $CaCl_2$, and urea subjected to elevated temperatures and CO_2 pressures. The CO_2 pressure is not critical above 2 or 3 atmospheres, but the temperature must be in the range 200°C. -250°C. to obtain dolomite. At lower temperatures basic magnesium carbonate and aragonite are formed, and at higher temperatures the formation of calcite and magnesite is favored. If the temperature is controlled to within $\pm$ 10° of 220°C., pure dolomite is precipitated.

The presence of NaCl in the solution extends the range of temperatures over which dolomite can be precipitated. Several other salts have the same effect, and the salt concentration influences the relative amounts of calcite, magnesite, dolomite, etc. which are formed in the precipitates. The influence of the salt is believed to be associated with changes in the activities of the various carbonates in solution.

The pH at which the dolomite precipitations occurred was not measured, but the pH's of the solutions which remained after precipitation were measured at ordinary temperature and pressure and found to be in the range 6.5-7.5. --Auth.

1-2839. Erd, Richard C., James F. McAllister, and Hy Almond. GOWERITE, A NEW HYDROUS CALCIUM BORATE, FROM THE DEATH VALLEY REGION, CALIFORNIA: Am. Mineralogist, v. 44, no.9/10, p. 911-919, map, diag., 2 tables, Sept.-Oct. 1959, 7 refs.

Gowerite is a new hydrous calcium borate, $CaO \cdot 3B_2O_3 \cdot 5H_2O$, from the Furnace Creek borate deposits of the Death Valley region, California. Globular minute clusters of gowerite form from the weathering of colemanite and priceite veins in some basaltic rocks in the Furnace Creek formation of late Tertiary age. Associated with gowerite are ulexite, meyerhofferite, ginorite, sassolite, hydroboracite, and an undescribed magnesium borate.

Gowerite is monoclinic and is optically biaxial (+), $\alpha = 1.484 \pm 0.002$, $\beta = 1.501 \pm 0.002$, $\gamma = 1.550 \pm 0.002$, $2V = 63°$ (calc.), $r > v$ slight, $Y = b$, $Z \wedge c = 27°$. Hardness 3, specific gravity 2.00 ± 0.01. Two chemical analyses of the mineral gave: CaO, 15.54, 15.46; SrO, 0.71, 0.71; B_2O_3, 58.14, 58.05; H_2O, 25.75, 25.77; total 100.14, 99.99%. Synthetic calcium hexaborate pentahydrate is identical with gowerite. The strongest lines of the X-ray powder patterns of both are at 8.2 Å (10), 4.11 Å (5), 3.19 Å (6), and 2.73 Å (5).

The mineral is named in honor of Mr. Harrison P. Gower of the U. S. Borax & Chemical Corporation, Los Angeles, California. --Auth.

1-2840. Bailey, Edgar H., Fred A. Hildebrand, C.L. Christ, and Joseph J. Fahey. SCHUETTEITE, A NEW SUPERGENE MERCURY MINERAL: Am. Mineralogist, v. 44, no. 9/10, p. 1026-1038, map, 2 tables, Sept.-Oct. 1959, 21 refs.

Basic mercuric sulfate, $HgSO_4 \cdot 2HgO$, has been found as a supergene Hg mineral in several quicksilver deposits in the more arid parts of the western United States, and is a common product on dumps of burnt ore and bricks from old Hg furnaces. This new mineral is named schuetteite after Curt Nicolaus Schuette, mining engineer, geologist, and specialist on Hg deposits.

As schuetteite has been found in natural occurrences only as thin films, it has been identified by comparing its X-ray pattern with that of basic mercuric sulfate prepared in the laboratory. Crystal, chemical, and microscopic data have been obtained chiefly from similar material occurring in greater abundance in dumps and old furnace bricks.

Schuetteite is canary yellow in color, but it differs from the yellow Hg oxychlorides in that it does not darken on exposure to bright light. No crystals suitable for goniometric or precession camera work have been found, but minute tabular hexagonal crystals lying in a flat position were observed to be dark between crossed nicols. The writers, knowing the mineral was hexagonal, indexed the X-ray powder patterns by using a simple and direct method, which appears not to be in general use, involving the known chemical formula and density. The hexagonal mineral has a cell with $a = 7.07_0$ Å, $c = 10.9_5$ Å (both +0.01 A) and a calculated density of 8.36 gm./cm.^{2}. The observed specific gravity is 8.18.

Optically schuetteite is unaxial, negative. Both indices of refraction are well above 2.10; birefringence is moderate to high. It is slightly pleochroic with E = orange-yellow and O = greenish-yellow.

In natural occurrences schuetteite has been found on cinnabar surfaces exposed to sunlight. It is believed to have formed through direct oxidation of cinnabar by oxygen-bearing surface water with sunlight providing energy to cause the reaction. $HgSO_4$ may be an intermediate product.

On dumps of burnt ore and on furnace bricks the basic mercuric sulfate forms beneath the surface and a different reaction is required. In these places it appears to result from the action of strongly acid sulfate waters on metallic Hg. This reaction requires higher acidity and more strongly oxidizing conditions than are normally met in nature; in those natural environments where such conditions might occur, Hg generally is present as a sulfide rather than as the native element. It therefore seems unlikely that quicksilver deposits have anywhere been appreciably leached or enriched by either of the processes that lead to the formation of the basic mercuric sulfate. --Auth.

1-2841. Pugh, Derek C. BARITE IN NORTHEASTERN BRITISH COLUMBIA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 8, p. 180-181, Aug. 1959.

Barite has been identified in veins in Permo-Pennsylvanian(?) dolomite 32 ft. below the base of the Triassic in the Fort St. John area, and has been observed in Mississippian(?) brecciated dolomite 9 to 15 ft. below the base of the Triassic in the Kahntah River area. --Auth.

1-2842. Claffy, Esther W., and Robert J. Ginther. RED-LUMINESCING QUARTZ: Am. Mineralogist, v. 44, no. 9/10, p. 987-994, graph, Sept.-Oct. 1959, 26 refs.

Red-cathodoluminescent quartz has been synthesized from amorphous silicic acid containing minor amounts of Al^{+3} and Mn^{+2}, in a reducing atmosphere at 1, 200°C. The emission spectrum shows a band extending from 5, 400 Å to >7, 000 Å, with a maximum 6, 500 Å. --Auth.

1-2843. Gokhale, K.V.G.K., and T.C. Bagchi. AUTHIGENIC TOURMALINE IN THE BANGANAPALLY STAGE (KURNOOL SYSTEM), INDIA: Jour. Sed. Petrology, v. 29, no. 3, p. 468-469, 2 illus., table, Sept. 1959, 4 refs.

Tourmaline grains from an orthoquartzite in the Banganapally stage (lowest Kurnool) from near Kalava, India (15°37'N. 78°12'E.) are described. Tourmaline makes up over 93% of the heavy minerals in the orthoquartzite. Overgrowths are seen on almost all the grains of tourmaline. Optical data are given for 8 varieties of tourmaline. The most abundant variety is black to deep brown Fe-schorlite (36%). The overgrowths are pale blue to colorless with refractive index ranging from 1.61 to 1.63. The tourmaline is detrital in a transgressive marine environment. The presence of authigenic tourmaline in the Banganapally conglomerate zone is important as a good stratigraphic marker for correlation purposes. --D. Carroll.

1-2844. Fuchs, Louis H., and Henry R. Hoekstra. THE PREPARATION AND PROPERTIES OF URANIUM (IV) SILICATE: Am. Mineralogist, v. 44, no. 9/10, p. 1057-1063, graph, table, Sept.-Oct. 1959, 9 refs.

Uranium (IV) orthosilicate, corresponding to the mineral coffinite, has been synthesized by a hydrothermal procedure. Preparative conditions including precipitation techniques, temperature, pH, and U oxidation state have been investigated. $USiO_4$ is a blue microcrystalline compound isostructural with thorite and zircon. The infrared spectrum of $USiO_4$ shows an absorption maximum at 11.1μ, characteristic of isolated SiO_4^{4-} tetrahedra. No evidence was found for hydroxyl substitution in the synthetic material. $USiO_4$ is stable to 1,000°C. in a vacuum and to 500°C. in air. --Auth.

1-2845. Honea, Russell M. NEW DATA ON GASTUNITE, AN ALKALI URANYL SILICATE: Am. Mineralogist, v. 44, no. 9/10, p. 1047-1056, 3 graphs, 7 tables, Sept.-Oct. 1959, 8 refs.

Gastunite is an alkali uranyl silicate with the composition $(K, Na)_2(UO_2)_3(Si_2O_5)_4 \cdot 8H_2O$. Chemical analysis recalculated after deducting impurities, gives SiO_2 - 31.2, UO_3 - 53.8, K_2O - 4.6, Na_2O - 0.9, H_2O - 9.5, total 100.0%. The proposed formula is supported by infrared absorption data. X-ray study shows the mineral to be othorhombic, space group Pnna (W. Outerbridge), a_o - 14.24, b_o - 35.84, c_o - 14.20, calculated specific gravity 3.97 (3.96 + 0.03 measured). Indexed powder pattern shows the strongest lines to be 7.12 (10), 3.56 (9), 9.10 (8), 4.83 (7), 3.31 (7). Optically biaxial positive with $\alpha = 1.604$, $\beta = 1.610$, $\gamma = 1.621$: 2V moderate, anomalous blue interference color. Habit: radiating acicular to fibrous aggregates. Hardness 2. Perfect (010) cleavage Gastunite occurs as a secondary mineral in radial aggregates coating chalcedony at the Red Knob mine, Muggins Mountains, Yuma County, Arizona; and in vesicular cavities in welded tuff at the Mammoth prospect, Presidio County, Texas. Also present in dense fine-grained pseudomorphs after uraninite from the Easton area, Pennsylvania. Hydrothermal synthesis data for the K, K plus Na, Na, ammonium, and hydronium analogues of gastunite are presented. --Auth.

1-2846. Wyllie, P.J. MICROSCOPIC CORDIERITE IN FUSED TORRIDONIAN ARKOSE: Am. Mineralogist, v. 44, no. 9/10, p. 1039-1046, 5 illus., graph, Sept.-Oct. 1959, 13 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. No. 58-70.

Progressive thermal metamorphism of Torridonian arkose by a picrite sill in Soay (Hebrides) [Scotland] has culminated in extensive fusion. Microlites of cordierite were precipitated from the liquid as colorless, 6-sided prisms (maximum dimension 0.06 mm.) with abundant magnetite inclusions. Refractive indices of the cordierite lie between 1.529 and 1.541, and (-) 2V is small. The cordierite is frequently twinned on (110), and rare cruciform twins are also present. The latter have (021) or (101) as the probable twin plane. Only (110) and (130) have been reported previously as cordierite twin planes. The distortion index, Δ (degree of distortion from hexagonal symmetry, measured by X-ray powder diffraction), is 0.08. From independent evidence, the maximum P_{H2O} was 430 kg./cm.^{2}, and the minimum temperature interval of cordierite crystallization was 1025° C. to 935°C. If P_{H2O} were less than 430 kg./cm.^{2}, the estimated crystallization temperatures would be higher. A useful temperature scale may be established by 1) correlation of the structural state of cordierite with estimated temperature and pressure of water vapor in buchites, and 2) extension of hydrothermal studies on synthetic cordierites. Both approaches are required because the crystallization history of cordierite may affect its structural state. It is probable that the crystallization histories of cordierites in most buchites followed similar patterns. --Auth.

1-2847. Galbraith, Frederic W., and Daniel J. Brennan. MINERALS OF ARIZONA: 3d ed. rev., Arizona, Univ., Bull., v. 30, no. 2; Phys. Sci. Bull. no. 4, 116 p., Sept. 1959.

A comprehensive listing of minerals reported from Arizona. The authors list over 500 minerals and mineral varieties with a brief description of each. Many chemical analyses are given, and a listing of localities is included under each entry. --R. T. Moore.

1-2848. Heyl, Allen V., Charles Milton, and Joseph M. Axelrod. NICKEL MINERALS FROM NEAR LINDEN, IOWA COUNTY, WISCONSIN: Am. Mineralogist, v. 44, no. 9/10, p. 995-1009, 10 illus., 2 maps, Sept.-Oct. 1959, 22 refs.

Ni minerals occur in comparative abundance as accessories in the upper Mississippi Valley Zn-Pb district of southwestern Wisconsin and northwestern Illinois as well as at other localities in Wisconsin, Illinois, Iowa, Missouri, and Indiana. Millerite is the most common. In SW. Wisconsin millerite is generally associated with violarite and bravoite(?), and near Linden all 3 have been partly altered to a green, yellow, and orange powdery product that is a hydrous basic Ni-Fe sulfate, or a series of related sulfates. The alteration product is extremely fine grained and obscurely fibrous; the mean index of refraction is about 1.615 and the birefringence is very low. The X-ray diffraction pattern of the material has broad lines not referable to any known mineral, and chemical analyses indicate that it is essentially a hydrous basic sulfate of Ni and ferric Fe.

Millerite was deposited near the end of the main period of deposition of the primary sulfides. The other Ni minerals are probably products of oxidation and secondary enrichment of millerite. A hitherto unrecognized type of symmetrical twinning in millerite, suggestive of a lower symmetry than rhombohedral scalenohedral, is described. --Auth.

See also: Geochemistry 1-2823; Mineralogy 1-2846; Mineral Deposits 1-2890, 1-2892.

1-2849. Butler, Gurdon Montague. PETROLOGY, CONDENSED AND SIMPLIFIED: Arizona, Univ., Bull., v. 30, no. 1; Arizona Bur. Mines, Mineral Technology Ser. no. 50, Bull. no. 166, 31 p., 2 figs., Sept. 1959.

The author briefly outlines the principal characteristics and modes of occurrence of the more common rock types and presents a simplified scheme of hand specimen identification. --R. T. Moore.

1-2850. Hay, Richard L. FORMATION OF THE CRYSTAL-RICH GLOWING AVALANCHE DEPOSITS OF ST. VINCENT, B.W.I.: Jour. Geology, v. 67, no. 5, p. 540-562, 2 illus., 5 maps, diag., 3 graphs, 5 tables, Sept. 1959, 28 refs.

Andesitic glowing avalanches discharged from the Soufrière of St. Vincent on May 7, 1902, deposited ash which is noted for its fine-grained texture and richness in crystals. The largest avalanche deposit of this eruption contains several percent of blocks and bombs and 15-30 % of lapilli. The median diameter in a representative sample is 0.6 mm., and the sorting coefficient is 2.9 Crystals form 45% of the bombs and have been concentrated to form almost 58% of all juvenile material in the deposit and 73% of the juvenile ash finer than 2 mm.

The glowing avalanches were discharged from the outer part of a vertical ash column which carried a large volume of ash to considerable elevations. When the column became denser than the surrounding atmosphere, it discharged clouds of pyroclastic material laterally. The clouds quickly became stratified into a lower, denser fraction (the glowing avalanches) containing the coarse ejecta and bulk of the crystals, and an upper part lighter and richer in gas and fine particles of vitric ash. A third or more of the material discharged was dispersed in the light, gas-rich clouds which accompanied the avalanches during their descent.

Glowing avalanches discharged by prehistoric eruptions which reached a climax 4,000 years ago deposited materials essentially similar to those of 1902. The prehistoric avalanche deposits, together with mudflows and stream-laid materials, filled valleys on the western side of the Soufrière and formed a large fan at its eastern foot.

The St. Vincent glowing avalanche deposits are chemically, mineralogically, and texturally rather similar to a number of pumice- and scoria-flow deposits. Crystals have been concentrated in the ash fraction of pumice-flow deposits of Crater Lake and Asama beyond their proportion of the magma, probably by the same mechanism as they were concentrated on St. Vincent. A scarcity of bombs in the St. Vincent deposits is apparently the only major difference between these and the scoria- and pumice-flow deposits of other volcanoes. --Auth.

1-2851. Poldervaart, Arie, and William H. Taubeneck. LAYERED INTRUSIONS OF WILLOW LAKE TYPE: Geol. Soc. America, Bull., v. 70, no. 10, p. 1395-1397, Oct. 1959, 15 refs.

A review of layering in igneous plutons is presented and the authors propose a classification of rhythmic layering with 2 types. 1) In layering of Skaergaard type crystals of constituent minerals show a preferred orientation of their longer axes in the plane of banding. Many large gabbroic plutons display this type. The type locality is the Skaergaard pluton, Kangerdlugssuaq, E. Greenland. The authors do not attribute this type of layering to water pressure during crystallization. 2) In layering of the Willow Lake type crystals of constituent minerals are typically arranged with their longer axes at high angles (60^{o}-90^{o}) to the layering. The type locality is designated as the Willow Lake intrusive in the Elkhorn Mountains, northeastern Oregon.

The Willow Lake type of rhythmic layering is due to undercooling and crystallization in the oversaturated region of the pluton, combined with periodic disturbances, mainly turbulent currents. Surprisingly, this type of rhythmic layering is common in western North America.

The writers discuss the cause(s) and characteristics of Willow Lake type layering and consider other igneous plutonic phenomena and their relationship to the 2 types of rhythmic layering. --I. M. Johnston.

1-2852. Saha, Ajit Kumar. EMPLACEMENT OF THREE GRANITIC PLUTONS IN SOUTHEASTERN ONTARIO, CANADA: Geol. Soc. America, Bull., v. 70, no. 10, p. 1293-1325, illus., 18 maps, 5 secs., 9 diags., 3 graphs, 10 tables, Oct. 1959, 28 refs.

The manner and history of emplacement of 3 post-tectonic granitic plutons in Hastings and Peterborough counties, Ontario, were studied using lithological and structural mapping, petrographic studies (including modal analyses, chemical analyses, radiometric and decrepitometric studies), and petrofabric studies. The country rocks consist of Grenville metasedimentary rocks which were folded in 2 stages along NE. - and ESE. -trending axes respectively, before emplacement of the plutons. The elliptical (5 by 3 mi.) Chandos Lake pluton is made up of a central body of foliated syenite-monzonite, surrounded by later foliated biotite granite grading to a granodiorite. Both components are steep-dipping, cross-cutting, funnel-shaped bodies emplaced by forceful intrusion at the site of a preexisting structural basin. The elongated body of the foliated Wollaston biotite-hornblende granite (6 by 1.5 mi.) was forcefully intruded along the eastern flank of a regional anticline as several steep E. -dipping bodies of granite, separated by narrow screens of paragneissic country rocks, parts of which were granitized to a granite gneiss. The composite Deloro pluton (20 sq. mi.) consists of an earlier crescent-shaped (on plan), forceful intrusion of perthite granite grading to syenite along the western border, followed closely by the intrusion of a smaller body of granophyric granite in the E.

The biotite granite-granodiorite of Chandos Lake pluton and the Wollaston biotite-hornblende granite show unsystematic variations of the modal quartz (Q)-feldspars (F)-mafic minerals (M) and the quartz (Q)-potassium feldspar (Kf)-plagioclase (Pl) proportions and of the α activity; assimilation of varied rock types by the granite magmas accounts for such variations. In the Deloro pluton assimilation of gabbro-diabase by the granite magma accounts for the syenitic western border, but magmatic differentiation by fractional crystallization caused a systematic trend of acidification toward the central and eastern parts of the pluton and the location of the Q-Pl-Kf plots of the perthite granites within the thermal valley of Bowen. The cooling of the plutonic rocks was accompanied by extensive recrystallization of

quartz in all the plutons, formation of myrmekite and of albite rims on plagioclase in the Chandos Lake and Wollaston plutons, and segregation of albite from the perthites in the Deloro pluton. --Auth.

10. SEDIMENTARY PETROLOGY

See also: Geomorphology 1-2724, 1-2728, 1-2729; Stratigraphy 1-2749, 1-2750, 1-2755, 1-2757, 1-2767; Geochemistry 1-2822; Igneous and Metamorphic Petrology 1-2849; Fuels 1-2909, 1-2910.

1-2853. Tanner, William F. SAMPLE COMPONENTS OBTAINED BY THE METHOD OF DIFFERENCES: Jour. Sed. Petrology, v. 29, no. 3, p. 408-411, 4 graphs, 2 tables, Sept. 1959, 6 refs.

The method of first and second differences permits, in certain instances, the detachment of major components from zig-zag curves. Because of the overlap between components, and other factors, the method is commonly subjective in part and therefore not rigorous. Three applications are shown, dealing with modern shoreline marsh samples and one dealing with an Eocene sand. Recombinations of the detached components provides curves which generally deviate from the original less than 2%. After components have been obtained, it is still not possible to identify the site of deposition of the sample. Additional applications are known from geomorphology, stratigraphy, river hydrology, and other branches of earth science. Because the results in geomorphic problems can be verified in the field, it is thought that the analysis of sediment samples is also meaningful. --Auth.

1-2854. Dreimanis, Aleksis. RAPID MACROSCOPIC FABRIC STUDIES IN DRILL-CORES AND HAND SPECIMENS OF TILL AND TILLITE: Jour. Sed. Petrology, v. 29, no. 3, p. 459-463, 2 illus., 5 diags., Sept. 1959, 10 refs.

Oriented till cores and hand specimens may be used for rapid macroscopic fabric studies by measuring the apparent long axes of particles on dissected or broken till surfaces. Preparation and measurements require only up to 1/2 hour per sample. Maxima in these fabric diagrams are not as pronounced as in those obtained by more precise techniques, and the transverse maxima tend to be exaggerated. In spite of these inaccuracies, the fabric maxima are found to be in close agreement with the known ice flow direction in 16 out of the 21 till samples measured. The described procedure is suitable also for rapid fabric studies in tillites. --Auth.

1-2855. Rogers, John J.W. DETECTION OF LOG-NORMAL SIZE DISTRIBUTIONS IN CLASTIC SEDIMENTS: Jour. Sed. Petrology, v. 29, no. 3, p. 402-407, 2 graphs, Sept. 1959, 10 refs.

The determination of the form of grain size distribution functions in clastic sedimentary rocks involves a certain amount of subjective interpretation. The subjectivity can be minimized, though not eliminated, by various analytical and interpretive methods. If the object of studying a size distribution is the interpretation of sedimentary history, probably the best method consists of making approximate analyses of a large number of samples and comparing theoretical distributions with whatever data are capable of being tested. --Auth.

1-2856. Herrin, Eugene T., H. Sterling Hicks, and Herbert Robertson. A RAPID VOLUMETRIC ANALYSIS FOR CARBONATE IN ROCKS: Field & Lab., v. 26, no. 3/4, p. 139-144, July-Oct. 1958, pub. 1959.

Rapid, accurate analyses for the CO_3 content of carbonate rocks may be made by allowing a known amount of the rock to react with a measured quantity of standard H_2SO_4 and then determining the amount of acid which remains by back-titration with standard NaOH. The technique is faster and more accurate than the leaching method and, more important, allows the analyst to determine directly the CO_3 content. Very accurate analyses for CO_3 in limestones may be made by potiometric titration methods, but quite satisfactory results are obtained using phenolphthalein as an indicator.

As is the case with igneous rocks, the classification of carbonate rocks may be based on modal composition as determined by studies of thin-sections or it may be based on chemical composition. The exact mineralogical composition of a rock cannot be determined from a chemical analysis. The weight percent CO_3 is a more meaningful index for the chemical classification of limestones than the percent carbonate mineral or the percent insoluble residue. --Auth.

1-2857. Baas Becking, L.G.M., and D. Moore. THE RELATION BETWEEN IRON AND ORGANIC MATTER IN SEDIMENTS: Jour. Sed. Petrology, v. 29, no. 3, p. 454-458, graph, 5 tables, Sept. 1959, 8 refs.

Use of the densitographic method shows that the Fe in sediments forms complexes, chiefly of a physical nature, with organic matter. The complex which is formed contains, in 80% of the cases, about 3 parts by weight of organic matter and 1 part of iron oxide. There are notable exceptions. Beach sand does not contain any appreciable amount of organic matter, and in certain "hardpans" the Fe content is much higher than that of organic matter. In other sediments the organic content is greatly in excess of the Fe. It is suggested that other metals, for example U in black shales, may form similar complexes. --Auth.

1-2858. Franks, Paul C., George L. Coleman, Norman Plummer, and William Kenneth Hamblin. CROSS-STRATIFICATION, DAKOTA SANDSTONE (CRETACEOUS), OTTAWA COUNTY, KANSAS: Kansas, State Geol. Survey, Bull. 134, pt. 6, p. 223-238, 6 illus., 2 maps (1 in pocket, scale approx. 1 in. to 2 mi.), 7 graphs, table, Aug. 1959, 19 refs.

Dip bearings of water-deposited cross-strata in sandstone of the Dakota formation (Cretaceous) of central Kansas were measured at 79 localities in Ottawa County. Vector-resultant (average) dip bearings lie in nearly all compass directions, but average S. 57°W., showing that transportation of Dakota sediments in Ottawa County was mainly from NE. to SW. and that the source, therefore, seemingly lay to the NE. Computation of a regression line of standard deviation on consistency ratio indicates that, in Da-

kota sandstone, consistency ratio is a good predictor of standard deviation for ratio values between 0.65 and 0.95. --Auth.

1-2859. Hardy, Clyde T., and J. Stewart Williams. COLUMNAR CONTEMPORANEOUS DEFORMATION: Jour. Sed. Petrology, v. 29, no. 2, p. 281-283, 3 illus., June 1959, ref.

Small scale columnar structures (individual columns are 6-8 in. in diameter and up to 3-4 ft. in length) occur in the Ute formation (Cambrian) about 5 mi. N. of Brigham City in the Wasatch Range of northern Utah. The best formed columns occur in 2 stratigraphic intervals of interbedded, thin-bedded, gray limestone and brown-weathering silty limestone. The columns consist almost entirely of gray limestone although surrounded by interbedded limestone and silty limestone. Photographs illustrate the relation of columns to surrounding beds. --D. Carroll.

1-2860. Rigby, J. Keith. POSSIBLE EDDY MARKINGS IN THE SHINARUMP CONGLOMERATE OF NORTHEASTERN UTAH: Jour. Sed. Petrology, v. 29, no. 2, p. 283-284, 2 illus., June 1959.

Spiral impressions in sandstone of the Shinarump conglomerate (Triassic) occur about 10 mi. N. of Vernal on the southern flank of the Uinta Mountains, Utah. The impressions are 1-3 ft. in diameter and have been cut 1/4 to 1/2 in. deep into the sandstone bedding surface. The sprials may have originated from movement of a tree branch caught in a vortex or eddy current of a stream that deposited the sandstone. --D. Carroll.

1-2861. Smith, Alec J. STRUCTURES IN THE STRATIFIED LATE-GLACIAL CLAYS OF WINDERMERE, ENGLAND: Jour. Sed. Petrology, v. 29, no. 3, p. 447-453, 4 figs. incl. illus., map, Sept. 1959, 9 refs.

The succession of sediments in Windermere in the English Lake District is composed of stratified late-glacial sands, silts and clays, post-glacial organic mud, and, at the top, surface ooze. A program of coring was commenced in the summer of 1958 in order to study the sedimentation and sedimentary history of the late-glacial sediments. The stratification of these sediments is marked, and consists of an alternation of sand-silt and clay layers. The sand-silt layers are usually laminated and graded. It is believed that these layers were deposited from bottom-sweeping currents. The alternation of coarse and fine layers resembles varves. It has been found that the correlation of the layers in cores is only possible over short distances; therefore, it is clear that the layers in these sediments cannot be used for dating.

Cores show that the sediments have been affected by post-depositional movements down the slopes of the lake basin. These movements range in scale from small movements affecting single layers to the oversteepening, overturning, and in some cases, the slumping of several feet of sediment. All movements appear to have ceased before the deposition of the organic mud. --Auth.

1-2862. Kugler, H. G., and J. B. Saunders. OCCURRENCE OF ARMORED MUD BALLS IN TRINIDAD, WEST INDIES: Jour. Geology, v. 67, no. 5, p. 563-565, 4 illus. on 2 pls., Sept. 1959, 3 refs.

Armored mud balls similar to those described from river deposits in California by Bell are found on the coasts of Trinidad. Among the Recent examples has been found one fine specimen of a fossil armored mud ball derived from Miocene Cruse sediments. Ellipsoidal, with a long axis of about 6 in., it is composed of hard, dense mudstone with an armor of chert, quartz, and quartzitic sandstone pebbles. --Auth.

1-2863. Bathurst, R.G.C. THE CAVERNOUS STRUCTURE OF SOME MISSISSIPPIAN STROMATACTIS REEFS IN LANCASHIRE, ENGLAND: Jour. Geology, v. 67, no. 5, p. 506-521, 7 illus., 3 maps, diag., Sept. 1959, 32 refs.

The knoll-reefs of Lancashire, Yorkshire, and Derbyshire are original mounds of fossiliferous calcite-siltstone up to 300 ft. or more thick. They contain thin layers and irregular masses of coarser calcite, known as reef "tufa" or "fibrous calcite," which are identical with the Stromatactis of Belgian and American Paleozoic reefs. The coarse mosaics in 2 reefs near Clitheroe, Lancashire, are shown to be drusy infillings of postdepositional cavities. The cavities were formed in a sediment made coherent by a sediment-binder, and later were complicated by compaction and internal erosion and solution. On the floors of many of the cavities are internal sediments different in appearance from the host sediment but presumably derived from it - possibly by some organic process.

There are 2 kinds of drusy mosaic - equant and fibrous. The latter has, in most fibers, a pattern of subgrains radiating away from the wall, allied to optic axes which converge away from the wall, as well as curved cleavages and irregular intergranular boundaries. As this type of fibrous mosaic may have important environmental significance, it is named "radiaxial fibrous mosaic."

The grain-size range of the primary siltstone (2.5-14μ) is markedly different from that of the standard calcite-mudstone (0.5-4μ). An original difference of environment is indicated.

A sediment-binder is considered necessary for the maintenance of steep slopes and cavity roofs. Bryozoa, algae, decomposing organic tissue, and carbonate cement are all regarded as unsuitable. An organic origin for Stromatactis is offered as an alternative.

Consideration is given to the formation of the cavities by a combination of erosion by migrating pore water (during compaction) and the decay of a hypothetical organism associated with Stromatactis. --Auth.

1-2864. Crook, Keith A.W. LITHOTOPIC RELATIONSHIPS IN DEEP-WATER TROUGHS: Jour. Sed. Petrology, v. 29, no. 3, p. 336-342, map, Sept. 1959, 16 refs.

Evidence from modern and ancient deep-water deposits enables the recognition of 3 lithotopes characteristic of deep-water troughs - a pelagic lithotope, a turbidity current lithotope (with higher- and lower-competency subdivisions) and a slump lithotope. The spatio-temporal relationships of these lithotopes are fundamentally different from those generally obtaining in shallow-water and terrestrial areas. These differences give rise to differences in

gross stratigraphic aspect between sequences accumulated in the different areas.
While the [Australian Code of Stratigraphic Nomenclature] is well suited to the description of shallow-water and terrestrial sequences, difficulties are experienced when it is applied to deep-water sequences. An example is cited from near Tamworth, New South Wales [Australia]. These difficulties are thought to be due to certain limitations in the concepts basic to the Stratigraphic Code, particularly the concept of lithotopic relationships. A reexamination of stratigraphic concepts to test their generality is suggested. --Auth.

1-2865. Carozzi, Albert V., and Walter R. Lundwall, Jr. MICROFACIES STUDY OF A MIDDLE DEVONIAN BIOHERM, COLUMBUS, INDIANA: Jour. Sed. Petrology, v. 29, no. 3, p. 343-353, 15 figs. incl. illus., map, secs., Sept. 1959, 8 refs.

The microfacies and statistical study of a Middle Devonian bioherm has revealed that, unlike many similar structures, the investigated one is a composite body in which a transgressive phase of stromatoporoidal growth overlying dolomites has been welded by a horn coral and echinoderm development to a regressive phase of stromatoporoidal growth which is itself overlain by another dolomitic zone. The ecological zones resulting from this strikingly cyclical evolution were found to be, in increasing relative depth order: matlike stromatoporoids, horn corals, and arenaceous Foraminifera, echinoderms, and ostracods. --Auth.

1-2866. Garner, H.F. STRATIGRAPHIC-SEDIMENTARY SIGNIFICANCE OF CONTEMPORARY CLIMATE AND RELIEF IN FOUR REGIONS OF THE ANDES MOUNTAINS: Geol. Soc. America, Bull., v. 70, no. 10, p. 1327-1368, 16 illus., map, 5 secs., profiles, 4 diags., table, Oct. 1959, 53 refs.

Portions of the Andes Mountains of South America close to sub-base-level depositional sites currently yield a wide variety of clastic material in suites ranging from dominant clay with sand to coarse boulder-clay composites, which indicates that present concepts, associating source-area tectonic intensity as expressed through relief with control of clastic size, require revision. Relief and source-deposit distance do not alone determine depositional clastic-size range in the Andes, because, of 4 source areas examined, all are extremely high, and 3 are very close to depositional sites. The element controlling clastic size of sediments is capable of producing differing results where relief and distance of transport remain relatively constant and country rock suites are varied. Evidence presented indicates that the governing element is climate.

Humid weathering, as a dominantly chemical process, generates fine clastic material which is protected from fluvial or eolian erosion by vegetation and forms soil. Arid weathering, as a dominantly mechanical process, generates a high percent of coarse alluvium which tends to accumulate within arid regions due to eolian removal of fine fractions and absence of perennial runoff.

Evidence presented shows that climate shifts can bring erosional and weathering processes of a given climate into contact with features previously developed by basically different processes. Regolith in a source and sediments yielded therefrom can reflect a single and prevailing climatic genesis (humid, Cordillera de la Costa, Venezuela; arid, Cordillera Occidental and coastal desert, Peru) or multiclimatic genesis where weathering and erosion have failed to eliminate inherited climatic effects (arid-humid transitions, Cordillera Oriental, Peru and Cordillera Occidental, Ecuador).

Clastic size being yielded by the 4 Andes regions correlates directly with vegetal cover, regolith, nature and/or competency of agents of transportation, and, therefore, climate. Sediments moved following a climate change tend to be weathering mixtures of a coarseness reflecting inherited regolith and progressing weathering and erosion.

The delay between the generation of a quantity of weathered material and its eventual delivery to a deposit by agents of subsequent climate(s) is designated sedimentary lag. Because movement of essentially all clastic material to sub-base-level deposits is characterized by sedimentary lag, the principle is important in tectonic-sedimentary relations and marine-nonmarine correlation. --Auth.

1-2867. Knill, John L. AXIAL AND MARGINAL SEDIMENTATION IN GEOSYNCLINAL BASINS: Jour. Sed. Petrology, v. 29, no. 3, p. 317-325, 6 maps, sec., Sept. 1958, 18 refs.

During the formation of geosynclines, graywackes tend to be deposited by axially directed turbidity currents; at the same time, a marginal facies may be developed. The lower Paleozoic geosyncline of Wales (Great Britain) contains some stratigraphical successions which appear to have been derived by both axial and lateral supply; the Harlech grits (Cambrian) and the upper Llandovery graywackes (Silurian) were deposited in NE.-SW.-trending basins which were margined by areas of shelf-sea. Similarly, the Crinan grits (Dalradian) of Scotland are partly made up of sedimentary material derived from the sides of the geosynclinal basin. The extent of interdigitation of the marginally and axially derived material appears to be associated with the form of the geosyncline. --Auth.

1-2868. Bathurst, R.G.C. DIAGENESIS IN MISSISSIPPIAN CALCILUTITES AND PSEUDOBRECCIAS: Jour. Sed. Petrology, v. 29, no. 3, p. 365-376, 6 illus., Sept. 1959, 24 refs.

The diagenetic histories of some Mississippian calcilutites from England and Wales are considered in the light of fabric criteria recently put forward by the author. It is concluded that calcite-mudstone was, at the time of its cementation, a mud of discrete calcite crystals, only slightly finer grained than the present mosaic. Whether the crystals had earlier inverted from aragonite it is impossible at present to say. Calcite-siltstones seem to have had a similar history, and evidence for cementation of original calcite crystals is to be seen in some examples. Criteria are presented for the distinction of mudstone aggregates (Bahamite "grains," faecal pellets, etc.) from relics of calcite-mudstone remaining after grain growth. Distinction is based on a study in thin section of the shapes of the finer grained areas and their distribution, and of the fabrics of the intervening coarser mosaics. The fabrics of pseudobreccia are described in detail and are shown to be the result of patchily developed grain growth. --Auth.

1-2869. Wolf, Karl H. BENTONITE?: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 1, p. 13-15, Jan. 1959, 10 refs.

It is suggested that in defining bentonites the definition of Pettijohn be accepted with the following addition: "Bentonite is composed mainly of claylike material which has been formed by the alteration of volcanic tuff and ash at the site of deposition."

Because the major component of the clay is usually montmorillonite, which breaks down into flakes or colloidal particles, bentonites have been identified by using the "expansion" test. This procedure is very unreliable for the following reasons: 1) different types of montmorillonite expand at varying rates or not at all; 2) montmorillonite may be formed independent of any volcanic material, or may be derived from an older volcanic rock; 3) the alteration products of volcanic deposits depend on many factors and need not be montmorillonite; 4) montmorillonite is very sensitive to environments and undergoes changes very readily. --Auth.

1-2870. Carroll, Dorothy. STATISTICAL STUDY OF HEAVY MINERALS IN SANDS OF THE SOUTH RIVER, AUGUSTA COUNTY, VIRGINIA: REVISION AND NOTES: Jour. Sed. Petrology, v. 29, no. 2, p. 284-287, 3 tables, June 1959, 2 refs.

Corrections of computation errors in the original paper are given (see Jour. Sed. Petrology, v. 27, no. 4, p. 387-404, 1957). --Auth.

1-2871. Harris, S. A. THE MECHANICAL COMPOSITION OF SOME INTERTIDAL SANDS: Jour. Sed. Petrology, v. 29, no. 3, p. 412-424, 2 profiles, 9 graphs, 4 tables, Sept. 1959, 14 refs.

The effect of wave action without longshore drift on the mechanical composition of sands is shown to consist chiefly of the removal of the finest grades from the material on the beach face. The mechanical composition of the parent material, not the sorting process, is the main influence controlling the grading range of the coarser fractions. The fields for plots of median versus logarithmic equivalent grade for dunes and beach deposits are different, and together with plots of the ranges of grades coarser and finer than the logarithmic equivalent grade, serve to readily distinguish between the 2 environments. In a reexamination of the shore zones of McKelvey, evidence is given for splitting his zone D into a beach face (DA) and beach flat (DB). --Auth.

1-2872. Griffiths, John C. SIZE AND SHAPE OF ROCK-FRAGMENTS IN TUSCARORA SCREE, FISHING CREEK, LAMAR, CENTRAL PENNSYLVANIA: Jour. Sed. Petrology, v. 29, no. 3, p. 391-401, chart, 4 graphs, 11 tables, Sept. 1959, 14 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. no. 58-60.

Variation in size, size-sorting, and axial proportions of fragments from a Tuscarora scree in central Pennsylvania is similar to variation in pebbles and quartz grains from other sedimentary deposits. The largest source of variation occurs among fragments, and no pattern of variation is evident over the small area sampled. This is in accord with expectations on the basis of sampling sediments which lie near their source and have suffered little selective sorting. --Auth.

1-2873. Reeves, Corwin C., Jr., and Harland Soper. CALCAREOUS SPRING DEPOSITS, DUBOIS AREA, WYOMING: Jour. Sed. Petrology, v. 29, no. 3, p. 436-446, 3 illus., map, 2 secs., Sept. 1959, 6 refs.

The thermal water deposits of the Dubois, Wyoming, area occur in 5 groups in the forms of domes, cliffs, flows, extinct geyser orifices, and natural bridges. The natural bridge group is not discussed. Two of the groups are along principal streams which flow perpendicular to outcrop strike; the remaining 2 groups parallel the strike of the outcrops.

The deposits, which are principally calcium carbonate, occur on strata ranging in age from Mississippian to Permian; the undoubted sources of the mineral enrichment were the underlying Paleozoic limestones. All of the thermal water deposits are underlain by a travertine cemented conglomerate which seemingly dates them as post-Pleistocene, but the correct age is dependent on the age of Warm Spring Canyon. The mineral-bearing waters reached the surface by travelling along bedding planes and possibly along faults. --Auth.

1-2874. Banerjee, A. PETROGRAPHY AND FACIES OF SOME UPPER VISEAN (MISSISSIPPIAN) LIMESTONES IN NORTH WALES: Jour. Sed. Petrology, v. 29, no. 3, p. 377-390, 6 figs. incl. illus., map, profile, graphs, table, Sept. 1959, 28 refs.

The petrography of a dominantly limestone succession is interpreted in terms of 3 depositional environments - deep shelf (or upper slope), lagoonal and shallow shelf. Special attention is paid to the composition of the limestones, their grain size and their depositional fabrics, all of which have been studied in thin section. Additional evidence is derived from a study of the associated shales and quartzose sandstones.

Point-counter analysis of the 4 main components in the limestones (calcite-mudstone, crinoidal debris, "other detritus," and calcite-siltstone) has led to a 5-fold natural classification into 1) shelly calcite-mudstone, 2) shelly calcite-siltstone, 3) coquina-lutite, 4) bioclastic calcarenite, and 5) crinoidal calcarenite. The coquina-lutites are again divided into 3 types on a basis of grain size and planar shape orientation of the skeletal particles. The classification is further supported by the results of grain size analysis.

Types 1, 2 and 3 and the clay shales are interpreted as lagoonal, types 4 and 5 as deep-water shelf (or possibly upper slope), and the quartzose sandstones, calcareous sandstones, sandy limestones, and silty shales as shallow-water shelf deposits. Possible fungal objects are recorded for the first time from the limestones. --Auth.

1-2875. McKee, Edwin D. STORM SEDIMENTS ON A PACIFIC ATOLL: Jour. Sed. Petrology, v. 29, no. 3, p. 354-364, 5 figs. incl. 3 maps, profiles, secs., 2 tables, Sept. 1959, 5 refs.

Deposits resulting from a single violent typhoon that struck a Pacific atoll [Jaluit, southern Marshall Islands; 6°N. 169°30'E.] consist of 1) coarse gravel ridges on the reef flat, 2) new or augmented beach ridges of gravel, 3) gravel sheets, ranging from 1/2 to 3 ft. in thickness, across two-thirds of some islets, and 4) sediment redeposited on the lagoon sides of many islets. These storm deposits differ greatly in texture and structure from those formed in corresponding places under normal environmental conditions. In addition, storm sediments of the

lagoon floor are relatively coarser at any particular depth than those formed under other conditions. Both storm and normal types are recognized in sections that expose earlier islet deposits. --Auth.

11. GEOHYDROLOGY

See also: Geologic Maps 1-2679; Geophysics 1-2819.

1-2876. Brown, Russell H. GROUND WATER MOVEMENT IN A RECTANGULAR AQUIFER BOUNDED BY FOUR CANALS: U.S. Geol. Survey, Ground Water Notes, no. 37, 22 p., 5 graphs, 4 tables, Sept. 1959, 3 refs.

The analytical procedures described in this paper afford a means either for determining the hydraulic characteristics of a rectangular aquifer using water-level data from recording-gauge charts or, conversely, if the hydraulic characteristics are known, for predicting water-table-recession curves for any point in the aquifer. In turn, these analytical exercises afford solutions to such practical problems as determining the adequacy of spacing of drainage ditches around nursery plots or other areas in which control of the water-table position is critical, and predicting water-table rises near irrigation canals. --Auth.

1-2877. Remson, Irwin, James R. Randolph, and Henry C. Barksdale. ZONE OF AERATION AND ITS RELATIONSHIP TO GROUND WATER RECHARGE: Am. Water Works Assoc., Jour., v. 51, no. 3, p. 371-378, illus., diag., table, March 1959, 15 refs.

Certain phases of the relationship of the zone of aeration to the water table, climatic factors, and ground-water recharge have been studied at Seabrook, New Jersey. Studies of movement of water in the zone of aeration were made by the U. S. Geological Survey at 2 favorable sites near Seabrook. These results are for specific conditions and cannot be assumed to apply elsewhere without further study. However, the results are believed to confirm Meinzer's 3-fold division of the zone of aeration, which is described in the article.

Discussed in the article are: ground-water recharge, suction and field capacity, and the zone of aeration with its 3 divisions - the capillary fringe belt, the intermediate belt, and the soil water belt. Following the discussion are some general observations, for example, the distribution of applied water throughout the length of the soil column, and the amount of water needed for substantial ground-water recharge. A table is included showing the penetration depths to which differing applications of water were traced during different months of the year at Seabrook. --L. M. Dane.

1-2878. Bouwer, Herman. THEORETICAL ASPECTS OF FLOW ABOVE THE WATER TABLE IN TILE DRAINAGE OF SHALLOW HOMOGENEOUS SOILS: Soil Sci. Soc. America, Proc., v. 23, no. 4, p. 260-263, 5 figs. incl. 2 graphs, 4 tables, July-Aug. 1959, 7 refs.

Hypothetical conductivity-tension relationships were employed in a study to determine the effect of the thickness of the capillary fringe and the relative conductivity above the capillary fringe on drainage flow. Solutions were obtained with an electrical resistance network using equivalent conductivities.

A capillary fringe of 50 cm. increased the drainage coefficients in shallow soil by 24 to 57%, depending on the height of the water table. Smaller increases can be expected with decreasing thickness of the fringe and increasing depth of the impermeable layer. Agreement existed between the results of the network analyses and calculated drainage coefficients, including the effect of the capillary fringe with Hooghoudt's method.

The effect of the flow above the capillary fringe on the drainage coefficient appeared to be small so that the flux across the top of the capillary fringe can be assumed to be uniform. Steady-state drainage coefficients, therefore, can be used to calculate the rate of fall of the water table after cessation of rain when the region near the top of the capillary fringe becomes a source of almost uniform flow because of drainage of pore space.

For a certain water-table position midway between drains, the water table in the vicinity of the drains appeared to be higher with increasing thickness of the capillary fringe. Since hysteresis causes the fringe thickness to be greater for falling water tables than for rising water tables, lower water tables near the drains can be expected with the latter. --Auth.

1-2879. Kirkham, Don. EXACT THEORY OF FLOW INTO A PARTIALLY PENETRATING WELL: Jour. Geophys. Research, v. 64, no. 9, p. 1317-1327, 4 figs., 3 tables, Sept. 1959, 14 refs.

An exact theory is presented for the flow into a well that partially penetrates a confined aquifer. An exact expression for the potential function is obtained, and from it an exact expression for the well flux is derived. Although the formulas obtained are complex, numerical calculations have been carried out for several flow geometries. Two flow nets have been prepared, one for a well of zero% penetration of the aquifer, the other, 60%. --Auth.

1-2880. Grainge, J. W. WATER SUPPLIES IN THE CENTRAL AND WESTERN CANADIAN NORTH: Am. Water Works Assoc., Jour., v. 51, no. 1, p. 55-66, 3 illus., map, table, Jan. 1959, 8 refs.

Area under consideration includes Yukon Territory, Mackenzie District, and southern Victoria Island. Rapid development of many communities has resulted in problems of water supply, sewage disposal, and sanitation. About a dozen communities (not including DEW Line stations) served by water and sewage systems now exist in this area, and within the next 5 years there will be at least 5 more. Some settlements are on silt deltas subject to considerable frost heaving where wells are generally unsatisfactory.

Physical geography of the region is briefly considered, then problems of wells at the various settlements, use of river water and lake water (especially Mackenzie River delta lakes), water from the ocean and from ice. Nature and distribution of permafrost and building construction in permafrost regions are described; also problems of water and sewer pipelines above and below ground in areas of permafrost and discontinuous permafrost. --A. C. Sangree.

1-2881. Davis, George H., Jack H. Green, Franklin H. Olmsted, and D.W. Brown. GROUND-WATER CONDITIONS AND STORAGE CAPACITY IN THE SAN JOAQUIN VALLEY, CALIFORNIA: U.S. Geol. Survey, Water-Supply Paper 1469, 2 v., v. 1, 287 p., v. 2, pls., 8 figs., 29 pls. under separate cover, 1959, 125 refs.

The San Joaquin Valley includes roughly the southern two-thirds of the Great Central Valley of California. It is a broad structural trough surrounded by mountains. The northern part of the valley drains through the San Joaquin River northward to San Francisco Bay; the southern part of the valley normally is a basin of interior drainage tributary to evaporation sumps in the trough of the valley, chiefly Tulare and Buena Vista Lake beds.

In years of normal discharge most of the streamflow in the southern part of the valley not diverted for irrigation finds its way to Tulare and Buena Vista Lake beds. In the historic past, however, during years of heavy floods the low divide between Buena Vista and Tulare lakes and the low divide between Tulare Lake and the San Joaquin River were overtopped and through-flowing drainage occurred over the full length of the valley. Because the Tulare Lake bed is the lowest point and also the largest sump, this whole basin of interior drainage is commonly referred to as the Tulare Lake drainage basin.

Average annual precipitation ranges from more than 15 in. in the northeastern part of the valley to less than 4 in. in the southwestern part. The precipitation decreases from N. to S. and from E. to W. across the valley. Streamflow, the critical quantity in the water supply, depends almost wholly on the amount and distribution of precipitation in the Sierra Nevada to the E. Much of this precipitation falls as snow, and the snowpack acts as a natural reservoir retaining much of the annual runoff until late spring and early summer.

The mean seasonal runoff to the San Joaquin Valley is nearly 10 million acre-ft., of which about two-thirds is tributary to the San Joaquin River; the remaining third is tributary to Tulare Lake drainage basin. In 1952 about 8.5 million acre ft. of surface water was diverted for irrigation. Withdrawals of ground water for irrigation in 1952 approximated 7.5 million acre-ft.

The surface of the San Joaquin Valley is not a featureless plain but is characterized by various types of physiography such as dissected uplands, low alluvial plains and fans, river flood plains and channels, and overflow lands and lake bottoms.

The dissected uplands fringe the valley along its mountain borders. They are underlaind by unconsolidated to semiconsolidated continental deposits of late Tertiary and early Quarternary age which have been moderately tilted and folded. The topography of these uplands ranges from deeply dissected hill land having a relief of several hundred feet to gently rolling land whose relief is only a few feet.

The low alluvial plains and fan border the dissected uplands along their valleyward margins. They are generally flat to gently undulating and featureless and are underlain by undeformed to slightly deformed alluvial deposits of Quaternary age.

The river flood plains and channels lie along the San Joaquin and Kings rivers in the axial part of the valley and along the major E.-side streams. Where the rivers are incised below the general land surface, the flood plains are well defined; but in the axial trough of the valley, where the rivers are flanked by low-lying overflow lands, the flood plain and channel deposits are confined to the stream channel and to the natural levees that slope away from the river.

Overflow lands and lake bottoms include the historic beds of Tulare, Buena Vista, and Kern lakes in the southern part of the valley, and the low-lying lands in the axial trough between the low alluvial plains and fans and the natural levees of the San Joaquin River and its major tributaries. They are level and featureless and are underlain by lake and swamp deposits of Recent age.

The San Joaquin Valley is a great structural downwarp between the tilted block of the Sierra Nevada on the E. and the complexly folded and faulted Coast Ranges on the W. The basement complex of the Sierra Nevada, consisting of igneous and metamorphic rocks of pre-Tertiary age, dips westward beneath the San Joaquin Valley. Indirect evidence suggests that the rigid Sierra Nevada block extends westward beneath the valley almost to the flanks of the Coast Ranges, thus forming a sharply asymmetrical trough whose axis is near the western border of the valley.

During much of the Cretaceous and Tertiary periods the San Joaquin Valley was the site of marine deposition and as much as several thousand feet of sediments accumulated. Overlying the marine sediments are continental deposits of late Tertiary and Quaternary age which in parts of the valley aggregate more than 10,000 ft. in thickness.

The Cretaceous rocks thicken westward and attain maximum thickness in the Coast Ranges. In the southern part of the valley the early Tertiary sediments likewise thicken westward and reach maximum thickness in the Coast Ranges. In the northern part of the valley, however, the early Tertiary deposits are comparatively thin where they crop out along the valley border. During late Tertiary and Quaternary time deposition was confined mostly to the present valley trough, although locally great thicknesses of deposits of these ages are exposed above the valley floor along its southwestern margin.

The late Tertiary and Quaternary deposits form the surface of the valley in an area of more than 10,000 sq. mi. These continental deposits range in thickness from a few feet along the valley border to as much as 16,000 ft. near the southern edge of the valley. For the most part the deposits contain fresh water which they yield freely to wells; locally, however, they contain brackish and saline water of poor quality.

The lithologic character of the continental deposits as interpreted from driller's logs, electric logs, and core records indicates that they are chiefly of fluvial origin, although, locally, sediments of lacustrine origin make up a substantial part of the continental deposits. The fluvial deposits consist of discontinuous, lenticular, and commonly elongated bodies of sand and gravel, sand, and silt laid down in stream channels, and discontinuous sheetlike bodies of silt and clay laid down by slow-moving overflow waters. The lacustrine sediments consist of beds of well-sorted clay and silt deposited on the floors of swamps and lakes, and some beds of well-sorted sand deposited in still water off the mouths of major streams.

Along the E. side of the valley is a series of coalescing alluvial fans, each characterized - where the stream issues from the mountains - by a mass of coarse permeable deposits that splays outward beneath the valley floor as lenticular tongues of well-sorted sand and gravel encased in a matrix of finer deposits, chiefly poorly sorted fine sand and silt deposited away from the stream channels on the alluvial plain. The interstream areas between the major alluvial fans are characterized by generally poorly sorted

fine-grained fluvial deposits laid down by small streams that drain the foothill regions between the drainage basins of the major rivers.

The streams that discharge upon the valley floor along the southern and western borders of the valley drain small areas on the lee side of the Coast Ranges, and, although the total runoff is small, these streams are subject to sudden floods. The sediments deposited are chiefly poorly sorted silt, fine sand, and clay and locally include a substantial proportion of the unsorted product of torrential stream deposition commonly identified as "clay and gravel."

Near the axial trough of the valley, the fluvial deposits of the E. and W. sides grade into and interfinger with lacustrine deposits: well-sorted clay deposited in lakes, silt and clay deposited in swamps, and well-sorted sand deposited in lakes near the mouths of rivers.

Few laterally continuous beds are present in the continental deposits. However, a bed of well-sorted lacustrine diatomaceous clay 10 to 160 ft. thick underlies about 5,000 sq. mi. in the western and central parts of the valley. Identification of the diatom flora indicates a probable late Pliocene age for the clay, equivalent to part of the Tulare formation. In addition to being the only laterally continuous marker in the continental deposits, the clay also is important in studying the hydrology and geochemistry of the valley. It is the principal confining bed in the valley, and it generally separates waters of different chemical character and concentration.

Throughout much of the valley 3 distinct bodies of ground water occur. In downward succession they are a) a body of unconfined and semiconfined fresh water which occurs in alluvial deposits of Recent, Pleistocene, and possibly very late Pliocene age overlying the widespread lacustrine diatomaceous clay bed; b) a body of fresh water confined beneath the clay bed in alluvial and lacustrine deposits of late Pliocene age; and c) a body of saline connate water contained in marine sediments of middle Pliocene or greater age which underlies the fresh-water body throughout the valley. Much of the eastern and southern parts of the valley are not underlain by the diatomaceous clay, and there the fresh-water body is in general unconfined to semiconfined.

The ultimate source of the ground water in the San Joaquin Valley is precipitation on the valley and its tributary drainage basins. Replenishment to the unconfined and semiconfined ground-water body is by seepage from streams, by underflow in the permeable materials flooring the canyons bordering the valley, or by losses from irrigation canals and ditches and deep penetration of water applied for irrigation in excess of plant requirements, and in small part by deep penetration of rainfall on the valley floor, especially in the northeastern part of the valley. Replenishment to the confined aquifers occurs chiefly from unconfined and semiconfined deposits beyond the featheredges of the confining beds but also in part from slow downward penetration of water through the confining beds in places where the artesian head in the confined aquifers has been drawn down by heavy pumping.

The ground water moves from areas recharge - chiefly areas irrigated by surface water diverted from the streams - to areas of discharge, which are chiefly areas irrigated by ground water pumped from wells, or natural drains in the vicinity of heavy surface-water application. Movement of the water in the confined deposits is toward areas of heavy withdrawal of ground water, which under present conditions is the principal form of discharge from those deposits.

In the northeastern part of the valley, N. of the Chowchilla River, surface-water supplies are generally adequate to supply irrigation demand and the ground-water reservoirs are maintained at near-full capacity. Seasonal fluctuations of water level register a general rise of the water table owing to heavy applications of irrigation water in late spring and early summer and a decline in autumn as irrigation decreases. The movement of ground water generally is from intensively irrigated areas on the alluvial fans toward natural drains that intersect the water table.

In the E.-central part of the valley, from the Chowchilla River S. to the Kaweah River, the long-term water supply generally has been nearly in balance with demand; however, because the surface-water supply decreases early in the summer, ground water is used to meet crop demands in late summer and autumn. Owing to this alternating pattern of irrigation, substantial seasonal fluctuations of water level occur as the ground-water storage is replenished when surface water becomes available for recharge, and later is depleted by pumping. Long-term trends of water level generally agree with long-term trends of runoff. Movement of ground water is generally from areas of heavy application of surface water for irrigation to areas of ground-water withdrawal and of natural discharge, chiefly stream courses and swampy areas.

In the southeastern part of the valley, from Lindsay S. to McFarland, surface-water supplies in the past have been generally inadequate to meet irrigation demands, and overdraft on ground-water supplies has been widespread. Water levels fluctuate in response to ground-water withdrawals. The water table declines rapidly in late spring and summer and recovers as pumping ceases late in the autumn. In overdrawn areas a year-by-year decline has occurred. Ground-water movement is from areas of recharge along the streams that cross the valley toward centers of heavy ground-water draft. In recent years, imports of surface water through the Friant-Kern Canal have supplied additional recharge to the ground-water reservoirs locally and have caused a reduction in pumping draft, thereby reversing the trend toward depletion.

The alluvial fan of the Kern River receives a generally adequate supply of irrigation water from that river; accordingly, conditions in that area are generally similar to those in the E.-central part of the valley. Seasonal fluctuations of water level register changes in ground-water storage in response to variations in pumping and recharge, and long-term fluctuations reflect long-term variations in the runoff of the Kern River. Ground water moves generally away from the alluvial fan of the Kern River toward adjoining areas of heavy ground-water withdrawal and toward areas of natural discharge near the axis of the valley.

The southern fringe of the valley, S. of the Kern River, is an area of low streamflow and heavy ground-water withdrawal for irrigation. Withdrawals greatly exceed the total replenishment, and water levels have declined steadily as ground-water storage was depleted. Seasonal fluctuations in water level register variations in pumping demand, but the long-term water-level trend has been downward. Ground water moves generally from the adjoining alluvial fan of the Kern River toward centers of pumping along the borders of the valley.

The W. side of the San Joaquin Valley is an area of generally deficient water supply. Rainfall is meager and the tributary streams carry little water. The

southwestern part of the valley, from Avenal S. to Maricopa, is a desert. It is largely uncultivated and is used chiefly for grazing. Western Fresno and Kings counties constitute an area of very heavy overdraft on ground-water supplies. Water levels in the confined aquifers have been drawn down rapidly in response to this heavy overdraft. The seasonal fluctuations register variations in pumping of ground water, but the year- to-year trends have been consistently downward. Movement of ground water is generally westward across the axis of the valley to this area of heavy withdrawals.

Much of western Merced, Stanislaus, and San Joaquin counties is irrigated by water diverted from the San Joaquin River. These areas of surface supply are generally more than adequately watered, and water levels accordingly stand near the land surface. Both seasonal and long-term fluctuations are small. Movement of ground water is toward natural drains that intersect the water table and westward to areas along the valley border that are irrigated with ground water.

The ground waters of the San Joaquin Valley are characterized by marked differences in both chemical character and concentration in lateral and vertical distribution. These differences are related to differences in composition of the rocks in tributary drainage basins, to differences in climate both present and past, and to physical and chemical changes that have occurred after the water has reached the ground-water body.

The streams of the E. side of the valley drain areas of heavy precipitation in the Sierra Nevada which are underlain by relatively insoluble igneous and metamorphic rocks of pre-Tertiary age. The waters, accordingly, are of low mineral content and are characteristically bicarbonate waters of the Ca or Ca-Na type. By contrast, the streams of the S. end and W. side of the valley drain areas of low precipitation in the Coast Ranges which are underlain chiefly by marine sediments of Tertiary and Cretaceous age and, in the N., by sedimentary, igneous, and metamorphic rocks of the Franciscan formation of Jurassic to Late Cretaceous age. The stream waters have higher concentrations of mineral matter than do the streams of the Sierra Nevada. Streams that drain extensive areas of Tertiary sediments generally carry sulfate water of the Ca or Na type. Streams that drain Cretaceous sediments and rocks of the Franciscan formation generally carry bicarbonate water of intermediate cation composition.

On the basis of areal differences the ground waters may be subdivided in quality into 3 main groups: a) ground waters of the E. side of the valley, generally of the bicarbonate type and of low to moderate concentration; b) ground waters of the axial trough, which range greatly in chemical character and concentration but are usually of higher concentration than the E. -side waters; and c) ground waters of the W. side of the valley, generally of the sulfate or bicarbonate type and nearly always of higher concentration than the waters of the E. side.

The ground waters may be subdivided roughly into 3 groups according to vertical differences in their quality: the unconfined and semiconfined waters, the confined waters, and the brackish and saline marine connate waters that underlie most of the valley. The chief difference between the unconfined and semiconfined waters and the underlying confined waters is that the confined waters generally contain smaller quantities of dissolved mineral matter but a higher proportion of Na than the overlying waters.

The gross ground-water storage capacity of the deposits between 10 and 200 ft. below the land surface in that part of the San Joaquin Valley considered potentially suitable for operation as a ground-water storage reservoir for cyclic storage is estimated at 93 million acre-ft. The storage capacity was obtained by multiplying an estimated average specific yield by the total volume of deposits within the 10- to 50-, 50- to 100-, and 100- to 200-ft. depth zones in 16 areal units defined by study of relative soil permeability and subsurface geology.

The average specific-yield values were derived as follows: a) Drillers' terms on 5,000 well logs used in the estimate were grouped in 5 lithologic classes, b) specific-yield values, based largely on work in other areas, were assigned to the 5 classes, c) storage capacity was calculated by multiplying the specific-yield values by the volume of deposits in each depth zone in township subunits within the 16 storage units, and d) the storage capacity was totaled by depth zones for each unit and for the valley as a whole.

The ground-water storage capacity is estimated at 20.1 million acre-ft., 25.1 million acre-ft., and 47.8 million acre-ft. in the 10- to 50-, 50- to 100-, and 100- to 200-ft. depth zones, respectively. Average specific-yield values used in the estimate ranged from as low as 4.8% in the 100- to 200-ft. depth zone of the Merced interstream unit to as much as 14.1% in the 10- to 50-ft. depth zone of the Kings River unit. The average specific-yield values for all 16 ground-water storage units were 10.6, 10.6, and 10.1% for the 10- to 50-, 50- to 100-, and 100- to 200-ft. depth zones, respectively, and 10.3% for all zones. --Auth.

1-2882. Smith, Rex O. GROUND-WATER RESOURCES OF THE MIDDLE BIG WOOD RIVER - SILVER CREEK AREA, BLAINE COUNTY, IDAHO: U.S. Geol. Survey, Water-Supply Paper 1478, 64 p., 9 figs. incl. map, graphs, secs., 5 pls. incl. illus., 3 maps (in pocket), sec. (in pocket), 6 tables, 1959, 11 refs.

The middle Big Wood River - Silver Creek area, lying between the mountains of central Idaho and the Snake River plain and drained in part by the Big Wood River and in part by Silver Creek - a tributary of Little Wood River - includes about 48,000 acres of lowland in Blaine County. About 20,000 acres of the lowland is irrigated, chiefly with surface water. Wells supply water to 575 acres and supplemental water to about 3,000 acres. About 7,500 additional acres of arable land could be irrigated if sufficient water were available. About 20,500 acres of the area is nonarable swamp, waterlogged land, and gravelly river bottom. Nearly all the surface water in the area has been appropriated for irrigation within, and downstream from, the area. The available natural flow is not adequate for late-season water demands within the area. Reservoir sites are available in the valley of the Big Wood River upstream from the middle Big Wood River - Silver Creek area, but the cost of large dams there probably would be too high to warrant their construction.

Water to supplement the supply for the presently irrigated land is wanted, and additional land might be irrigated if water could be obtained for it. The U.S. Bureau of Reclamation is considering proposals to install additional irrigation wells in the area, and to construct a small upstream storage reservoir. The river, the reservoir, and the wells then might be managed so that consequent reduction of the amount of water available for downstream storage in Magic

Reservoir would be offset by delivery of pumped ground water to the reservoir.

This report is a general evaluation of the ground-water resources available for the irrigated area and of the relation of the ground-water supply to the discharge of streams and existing water wells.

Pre-Tertiary basement rocks form the relatively impermeable floor of a basin which is partially filled with fluvioglacial sediments, and alluvium basalt, all of Quaternary age. The Quaternary materials yield both artesian and unconfined ground water copiously to wells and springs. The ground-water reservoir receives recharge by underflow from the N. (upstream), by direct infiltration of precipitation and irrigation water, by seepage from certain reaches of the channel of the Big Wood River, and by mass percolation from surrounding highlands. Ground water is discharged by springs which give rise to Silver and Spring creeks, by seepage into some reaches of the Big Wood River, by evapotranspiration, by wells, and by underflow through a southeastern outlet from the basin.

Among 28 representative irrigation wells the average yield of pumped wells is 1,875 gallons per minute (g. p. m.) and of flowing artesian wells, 825 g. p. m. The depth to the water table ranges from 70 ft. below the land surface in the northern part of the area to zero in the southern part. The average depth is about 18 ft. The piezometric surface of the artesian water in the small area where it was measured averages 27 ft. above the land surface. Water-table wells range in depth from 23 to 81 ft. and average 59 ft. Flowing artesian wells range in depth from 118 to 174 ft. and average 139 ft. The estimated withdrawal of ground water for irrigation in 1954 was about 7,500 acre-ft. Ultimately, new development might increase the yearly withdrawal to about 60,000 acre-ft. Of the total of 60,000 acre-ft., probably about 21,000 acre-ft. a year would be consumptively used - about 10% of the estimated total supply of ground water. That amount of depletion probably would not infringe materially on existing use of surface water from spring-fed streams, if pumping were restricted to strategic times and places. Some water that otherwise would escape by underflow southeastward out of the basin might be salvaged by pumping.

The ground-water reservoir is capable of yielding a large amount of water to wells. Increased pumping would cause general lowering of the water table and of the artesian pressure in the lowland, but the lowering probably would be small if pumping were properly managed. Nonartesian wells that yield 2,000 to 3,500 g. p. m. with an average drawdown between 10 and 20 ft., and artesian wells that yield 500 to 1,500 g. p. m. by free flow, could be developed in the central part of the area, where pumping lifts probably would range between 20 and 70 ft. The most suitable area for pumping supplemental irrigation water is in the central part of the area, but other areas are described in which such pumping would be feasible.

Construction and operation of a small storage reservoir upstream from the irrigated area might be desirable in a balanced program of water management.

One alternative plan of the Bureau of Reclamation proposes that the full additional water supply be obtained from wells. Water from well fields might be distributed through existing canals, but single wells or dispersed small groups of wells would be advantageous under some circumstances.

If increased pumping from wells in the central part of the area should deplete the surface-water supply to a greater extent than is desirable, the depletion might be offset by pumping water for replacement from the southeastern part of the basin, where estimated unused underflow out of the basin is about 30,500 acre-ft. yearly. The pumped water would be discharged for downstream surface diversions. Additional exploration and study of the southeastern area is advisable. By recognized standards the ground water and surface water in the basin are chemically suitable for irrigation. --Auth.

1-2883. Rosenshein, Joseph S. HYDROLOGIC INTERRELATIONS OF GROUND AND SURFACE WATERS AT LAFAYETTE: Am. Water Works Assoc., Jour., v. 51, no. 4, p. 503-510, map, 2 secs., 8 graphs, Apr. 1959, 4 refs.

Industries and cities make increasing demands upon Indiana water resources. A better understanding of the basic interrelations of ground water and surface water is needed in order to develop water resources wisely in the future. The conditions at Lafayette illustrate the interrelation of ground water and surface water. "Similar conditions exist at other localities along the larger streams of Indiana. The effect of heav pumping of wells upon streams, or other surface water bodies, depends on the distance of the wells from the surface water, as well as on the geologic and hydrologic conditions within the pumping area. In practical application, well fields are established near streams in order that a readily available source of recharge may be utilized, either by directly withdrawing water from the stream by induced infiltration, under favorable conditions, or by diverting part of the ground water contribution to the stream. The net result is the same. Therefore, it is not necessary to pump water directly from a stream in order to decrease its flow. Because of the interrelations of ground water and surface water, ground-water hydrology must be considered in evaluating the factors affecting stream flow. These same hydrologic interrelations must be taken into consideration in any attempt to formulate legislative controls of diversion of ground and surface water."--From auth. concl.

1-2884. Bock, Wilhelm. THE GROUND WATER PICTURE OF THE TRIASSIC OF SOUTH-EASTERN PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 33, p. 162-184, 5 figs., 1959, 3 refs.

The results of a study of many water companies in southeastern Pennsylvania, their water capacities and economic relationships, are broadly discussed. The importance of ground and surface water and their geological background in this region is emphasized. The water flow characteristics of the different Triassic rocks and soils were investigated, and new curves of water flow under head pressure introduced. --Auth.

1-2885. Newcome, Roy, Jr., and Ollie Smith, Jr. GROUND WATER RESOURCES OF THE CUMBERLAND PLATEAU IN TENNESSEE: 72 p., Nashville, Tennessee, Dept. of Conservation & Commerce, Division of Water Resources, 1958, 5 refs.

Ground water in the Cumberland Plateau physiographic province in Tennessee occurs almost exclusively in fractured sandstone beds, but cavernous limestone is important locally. The sandstones are interbedded with shales which serve as confining beds. The water is under artesian pressure, with the result that it rises in wells when the aquifers are penetrated.

Sufficient quantities of water for domestic use generally can be obtained from wells less than 100 ft. deep. The larger supplies necessary for schools, small industries, and municipalities require deeper drilling to as much as 170 ft. on the average. Wells yielding 50 gallons per minute or more are rare. The largest yields are obtained from cavernous limestones in the Sequatchie Valley.

Samples of water from 30 wells were analyzed for mineral content. The ground water is generally potable, although in places it contains Fe in high concentrations. Much of the water has a pH of less than 7.0; some of it has a pH as low as 4.5. --Auth.

1-2886. Schreurs, Raymond L., and Melvin V. Marcher. GEOLOGY AND GROUND-WATER RESOURCES OF THE DYERSBURG QUADRANGLE, TENNESSEE: Tennessee, Dept. Conserv., Div. Geology, Rept. Inv. 7, 61 p., 10 illus., 3 maps (in pocket) scale 1:63,360, 5 tables, 1959, 14 refs.

The Dyersburg 15-min. quadrangle, in northwestern Tennessee, lies on the eastern flank of the syncline that forms the Mississippi embayment. Sedimentary rocks of Eocene age underlie the entire quadrangle.

The lowermost beds in the upper part of the Eocene are principally fine to medium sand, which compose an aquifer that provides water for municipal and industrial use. Hydraulic tests indicate that the coefficient of transmissibility is 140,000 g. p. d. (gallons per day) per ft. and the coefficient of storage is 3.9×10^{-4}. The middle beds in the upper part of the Eocene are mainly silt and clay. The clay beds contain sand lenses that are tapped by wells for domestic water supplies. The uppermost beds of the Eocene are silty and sandy clay. Sandy gravel of Pliocene age and terrace sands of Pleistocene age yield water for domestic use.

Coarse-textured alluvial deposits of Pleistocene age underlie the Mississippi River alluvial plain and the Obion and Forked Deer River valleys. These deposits form an excellent aquifer that is tapped by irrigation wells. Hydraulic tests indicate that the aquifer beneath the Mississippi River plain at one locality has a transmissibility of 280,000 g. p. d. per ft. and a storage coefficient of 8.5×10^{-4}, and that the aquifer beneath a locality in the Forked Deer River valley has a transmissibility of 65,000 g. p. d. per ft. and a storage coefficient of 1.3×10^{-3}.

Water from aquifers now used as a source of supply is of the calcium bicarbonate type. Total hardness ranges from 49 to 406 p. p. m. --M. V. Marcher.

1-2887. Morris, D.A., O.M. Hackett, K.E. Vanlier, and E.A. Moulder. GROUND-WATER RESOURCES OF RIVERTON IRRIGATION PROJECT AREA, WYOMING: U.S. Geol. Survey, Water-Supply Paper 1375, 205 p., 28 figs. incl. 4 maps, diags., graphs, 6 pls. incl. 5 illus. on 3 pls., 3 maps (in pocket), 18 tables, 1959, 29 refs.

Irrigation by surface-water diversion is supplied to 77,716 acres. The area is characterized by flat to gently sloping stream terraces, flanked by badlands, pediment slopes, and broad valleys. The principal perennial streams are Wind River and Fivemile Creek. Ground-water discharge and irrigation return flow have created a major problem in erosion control along Fivemile Creek.

The bedrock in the area ranges in age from Late Cretaceous to early Tertiary. The Wind River formation forms the uppermost bedrock formation in the greater part of the area.

Water for domestic use is obtained chiefly from the Wind River formation although some is from the alluvium underlying the bottom land and from the unconsolidated deposits along the Wind River. Adequate quantities of water for irrigation are not available from the Wind River formation.

Waterlogging and associated saline soils are common in the Riverton project and are the result of infiltration of irrigation water in excess of the capacity of the aquifers to store and transmit this added recharge. An aquifer test of the Wind River formation indicates a transmissibility of 10,000 gallons per day per foot.

Water from shallow aquifers in irrigated tracts generally contains large amounts of dissolved solids. Wells tapping beds that recharge from influent canal and drain seepage yield water of low mineralization. Water from deep aquifers generally is more dilute than that from shallow aquifers. However, water from the deeper aquifers generally has a percent Na greater than 80.

Salt crusts on the ground surface in low areas are predominantly sodium sulfate. Analysis of soil and shale samples show harmful concentrations of salts are being deposited in poorly drained areas. --Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 1-2670 through 1-2673; Areal and Regional Geology 1-2684; Geophysics 1-2804, 1-2805; Geochemistry 1-2825; Mineralogy 1-2835, 1-2841.

1-2888. Tennant, Charles B., and Malcolm L. White. STUDY OF THE DISTRIBUTION OF SOME GEOCHEMICAL DATA: Econ. Geology, v. 54, no. 7, p. 1281-1290, 7 graphs, Nov. 1959, 7 refs.

An examination of geochemical data is made by statistical methods. Values are plotted on logarithmic probability paper. In most cases results suggest that more than one distribution may be present. Examples and proposed interpretations are given for data for mineralization in rock and soil, for biogeochemical values, for Fe in soil, and clay size material in soil. It is suggested that such tests may be useful in exploration and in evaluation of some of the large amounts of collected geochemical data. --Auth.

1-2889. Warren, Harry V., and Robert E. Delavault. READILY EXTRACTABLE COPPER IN ERUPTIVE ROCKS AS A GUIDE FOR PROSPECTING: Econ. Geology, v. 54, no. 7, p. 1291-1297, Nov. 1959, 12 refs.

This investigation explores the possibility of ascertaining the mineral potentialities of an area around an outcrop of limited size using rock analyses involving a chemical attack of moderate intensity. By using hot aqua regia, which does not substantially attack silicates, wide variations in the Cu content of plutonic rocks have been noted.

In general, our preliminary results suggest that, in the vicinity of mineralization, the readily extractable Cu of plutonic rocks is from 5 to 10 times greater than that from rocks unrelated to mineralization. This technique may prove useful in exploration and prospecting. --Auth.

1-2890. Stoiber, Richard E., and Edward S. Davidson. AMYGDULE MINERAL ZONING IN THE PORTAGE LAKE LAVA SERIES, MICHIGAN COPPER DISTRICT. PART I: Econ. Geology, v. 54, no. 7, p. 1250-1277, 3 illus., 8 maps, sec., 3 tables, Nov. 1959.

In the Portage Lake lava series of the Keweenaw Peninsula, Michigan, 3 overlapping amygdule mineral zones - prehnite, epidote, and quartz zones, respectively - can be distinguished. Higher stratigraphic horizons typically lie within the prehnite zone and lower horizons within the epidote and quartz zones. Zone boundaries cross stratigraphic horizons, indicating that the amygdule minerals were deposited after many successive flows were extruded. Temperature control of the over-all distribution is likely. Mineralogy of flow tops of the Keweenawan series throughout the Lake Superior basin is like that of Keweenaw Peninsula, indicating that the mineral zones have regional extent.

Cu concentrations are commonly near the boundary of the quartz zone, but may lie well within the quartz zone where quartz is not abundant. Most barren areas and unsuccessful mines lie either well outside the quartz zone, or where quartz or prehnite or both are plentiful. Detailed mineral mapping of mines on the Kearsarge amygdaloid shows that quartz is a prominent mineral only in the deeper portions of the mined area and that major concentrations of Cu lie near the boundary of the quartz zone.

In the Kearsarge amygdaloid deposition temperatures of quartz and calcite, determined by inclusion thermometry, reach a maximum of about 360°C.; this indicates a temperature gradient of greater than 2°C. per 100 ft. at the time of deposition, in contrast to a gradient of 0.6°C. per 100 ft. at the present time - indicating that fluids of hydrothermal character, rising along the flow top, deposited the amygdule minerals, one of which is native Cu. The chemical constituents of epidote, prehnite, and quartz, and the wide distribution and post-extrusion age of these minerals is compatible with formation by regional hydrothermal rearrangment and alteration of materials of the lavas as shown by chemical analyses of the altered rocks of the Kearsarge flow top. Pumpellyitization of parts of the flow top, caused by calcium oxide- and carbon dioxide-bearing waters, provided material to alter other parts of the top to albite basalt. Both alteration processes freed chemicals that formed amygdule minerals.

A slightly greater volume of pumpellyitized rock than albitized rock is needed to provide the chemicals required for region-wide formation of amygdule minerals. The suggestion is made that pumpellyitization at depth is more extensive than in the ground now opened by mining and that the chemicals freed were transported regionally upward by hydrothermal solutions. Cu distribution seems related to the zonal amygdule mineral pattern resulting from this alteration and may itself have been freed from the lavas at depth during alteration to pumpellyite. --Auth.

1-2891. Howard, Peter F. STRUCTURE AND ROCK ALTERATION AT THE ELIZABETH MINE, VERMONT: Econ. Geology, v. 54, no. 7, p. 1214-1249, 19 figs. incl. maps, secs., diags., table, Nov. 1959, 39 refs.

The Elizabeth Cu mine in E.-central Vermont is a concordant ore body lying within medium to high-grade metamorphic rocks of the Gile Mountain formation, believed to be Ordovician in age.

The major structural features of the district are the E.-dipping eastern limb of the Green Mountain anticlinorium, and the Strafford dome, which is marked by the development of an abnormal "Christmas-tree" pattern of minor folds. Due to a flat northerly plunge, the easterly part of this structure crops out as a series of recumbent dextral folds in which the older rocks appear on the inside of the northerly-plunging V structures. Minor sinistral folds and flexures are common in the area, and both pre- and post-date the dextral folds associated with the Strafford dome.

The Elizabeth ore bodies are bedded within the rock sequence at the contact of amphibolite and mica schists and are structurally related to the "Christmas-tree" pattern of folds. The ore is localized in fold positions and on straight limbs between fold positions. Schist breccia within the ore, ore infilling the space between parted bedding planes in drag fold positions, and veins filled with ore suggest that the ore was introduced into permeable zones formed during deformation and dated as middle and/or late Devonian (Acadian). It is believed that the major ore control in the district was the crushed and folded contact of thick competent amphibolite beds with incompetent schists interbedded with quartzites. --Auth.

1-2892. Cameron, Eugene N., and Mark E. Emerson. THE ORIGIN OF CERTAIN CHROMITE DEPOSITS OF THE EASTERN PART OF THE BUSHVELD COMPLEX: Econ. Geology, v. 54, no. 7, p. 1151-1213, 42 illus., 3 maps, chart, 2 secs., 3 diags., graph, 3 tables, Nov. 1959, 45 refs.

Structural and lithologic characteristics of the sequence of rock units in the critical zone of the Bushveld complex, on farms Winterveld and Jagdlust, eastern Transvaal, are described, and the sequence of rocks including the Steelpoort and Leader chromite seams is discussed. Field observations are consistent with the concept that the layered structure of the critical zone is due fundamentally to gravitative accumulation of early-formed crystals, but numerous irregularities and discontinuities of layering, repetition of rock types, and cognate xenoliths indicate sedimentation from a magma that was at least intermittently in motion.

The Steelpoort seam consists of a high-grade chromitite member 44 to 48 in. thick, enclosed in 2 low-grade members that grade into enclosing pyroxenites. The Leader seam consists of a high-grade chromitite member and an overlying low-grade member that grades upward into pyroxenite. Textural features of the pyroxenites and low-grade chromitite members can be accounted for satisfactorily by magmatic sedimentation of crystals of bronzite and chromite, followed by crystallization of interstitial liquid However, textural features of the high-grade chromitite members, together with bronzite-chromite overgrowths on xenoliths and chromite veinlets in xenoliths, indicate that while the main concentration of chromite is best explained by magmatic sedimentation, chromite in the high-grade chromitite members has crystallized in part in situ.

Bronzite and chromite vary systematically in grain size and composition through the pyroxenite-chromitite sequence. From this and the textural features, it is suggested that formation of the high-grade chromitite members involved partial resolution and reaction of settled crystals with magma prior to burial, followed by reaction between settled crystals and interstitial liquid after burial. The interstitial liquid, enriched in Cr and Fe, subsequently crystallized to give bronzite, more chromite, and minor plagioclase.

Downward diffusion into the interstitial liquid during crystallization may have contributed to the growth of chromite.

Formation of the chromites by accumulation of residual liquids rich in Cr and Fe is excluded by field evidence and by the paragenetic sequence of minerals in the rocks associated with the chromitites. Liquid immiscibility may have played a supplementary role in formation of the chromitites, but field and microscope evidence are against immiscibility as a principal mechanism of chromitite formation. --Auth.

1-2893. Brown, C. E. Gordon, A.S. Dadson, and L.A. Wrigglesworth. ON THE ORE-BEARING STRUCTURES OF THE GIANT YELLOWKNIFE GOLD MINE: Can. Mining & Metall. Bull., v. 52, no. 564, p. 235-244, illus., 5 maps, 3 diags., table, Apr. 1959, 11 refs.; also pub. as: Can. Inst. Mining & Metallurgy, Trans., v. 62, p. 107-116, 1959.

The ore bodies of the Giant Yellowknife mine [Great Slave Lake, Northwest Territories] occur in zones of schist, in an assemblage of typical Precambrian greenstones which form part of the Yellowknife Greenstone belt. One of the most interesting problems at the mine concerns the foldlike attitudes assumed by the schist zones. The internal structure of the zones and ore bodies provides much evidence of folding. A logical conclusion would be that the zones represent a single horizon which has been folded and drag-folded in the ordinary course of mountain building. However, surface mapping, and correlation of certain marker-horizons, in underground work, indicate a homoclinal succession of steeply dipping flows. If this concept of the geology is correct, the zones must crosscut the regional strike at a small angle and, in the over-all aspect, the regional dip at a large angle. A mechanical interpretation of the zone structure is presented as a suggestion for the present until new evidence is found. --Auth.

1-2894. Johnson, Henry S., Jr. URANIUM RESOURCES OF THE CEDAR MOUNTAIN AREA, EMERY COUNTY, UTAH. A REGIONAL SYNTHESIS: U.S. Geol. Survey, Bull. 1087-B, p. 23-58, 6 maps, table, 1959, 23 refs.

The results of field reconnaissance and office study of available data pertaining to the Cedar Mountain area, Emery County, Utah, are presented in this report, which is part of a series of reports synthesizing the geologic relations of U deposits in all stratigraphic units on the Colorado Plateau. Results suggest that the Chinle and Morrison formations and possibly the Cedar Mountain formation have further potential for sandstone-type U deposits in the area. Appraisals of unexposed units are based on the premise that primary sedimentary features are the major control of favorable ground, and geology and data on frequency of ore deposits are in part extrapolated from the San Rafael swell to the Cedar Mountain area. If tectonic structural features such as the San Rafael swell should be the major control, the U ore potential of the Cedar Mountain area may be considerably less than is suggested herein.

The Monitor Butte member of the Chinle formation is considered generally favorable for U deposits in a broad northwestward-trending belt paralleling the line of pinchout of this member in the southern third of the Cedar Mountain area. Sandstone lenses approaching the thickness (as much as 30 ft. thick) of the lens at the Delta mine in the neighboring San Rafael swell may contain ore deposits as large as 100,000 tons in size. Depths to this unit are everywhere greater than 1,000 ft.

The Moss Back member of the Chinle formation is thought to be generally favorable for U deposits over most of the southern third of the Cedar Mountain area. In this member, channels or wide, shallow channel systems, such as that passing through Temple Mountain and Green Vein Mesa in the San Rafael swell, are thought to be favorable for U deposits 10,000 to 100,000 tons in size. Depths to this unit are also greater than 1,000 ft. within the Cedar Mountain area.

The Salt Wash member of the Morrison formation has been the source of about 90% of all U ore mined in the Cedar Mountain area but has not been found to contain deposits larger than a few hundred tons in size. This unit is thought to be generally unfavorable for U deposits in this area except in a belt coinciding with a lobe of thicker Salt Wash trending northwestward through T. 20 S., R. 9 E., Salt Lake meridian. This lobe of thicker Salt Wash is interpreted as representing a trunk channel system on the depositional fan formed by the Salt Wash member.

Minor U occurrences also are known in the Brushy Basin member of the Morrison formation and in the upper shale member of the Cedar Mountain formation in the Cedar Mountain area. U in these deposits is associated with carbonaceous material in siltstone or claystone, and ore grades are commonly submarginal. These units may, however, contain fairly large tonnages of low-grade U-bearing rock. --Auth.

1-2895. Kidd, Donald J. IRON OCCURRENCES IN THE PEACE RIVER REGION, ALBERTA: Research Council Alberta, Geol. Div., Prelim. Rept. 59-3, 38 p., illus., geol. map, 1959.

Fe-rich Upper Cretaceous sandstones of northwestern Alberta are described, and reserves of potential Fe ores discussed. This report is based on field and laboratory studies and on subsurface information. Significant quantities of Fe are present in sandstones in the Clear Hills; sandstones on Swift Creek and at Worsley are the most ferruginous. The Swift Creek deposit consists of oölites of goethite and quartz in a matrix of goethite, quartz, and siderite. The Fe content ranges from 11.0 to 37.17% and averages 31.55%. The bed underlies 43 sq. mi. and has reserves of 1.5 billion tons. The sandstone at Worsley is similar in composition to that on Swift Creek, but also contains some calcite. The average Fe content is 35%, and reserves are estimated at 136 million tons. Silica and P contents of both deposits are perhaps too high for standard North American smelting methods, but a concentrate suitable for blast furnace operation can be prepared. --R. Green.

1-2896. Rose, E.R. IRON DEPOSITS OF EASTERN ONTARIO AND ADJOINING QUEBEC: Canada, Geol. Survey, Bull. 45, 120 p., 13 illus. on 8 pls., 23 maps (5 in pocket), 10 tables, 1958, 100 refs.

This report deals with geological features of the magnetite and hematite deposits of a region comprising some 16,000 sq. mi. in eastern Ontario and that part of Quebec near the lower Ottawa River. It summarizes the results of an investigation made during 1952, 1953, and 1954.

The Fe deposits of eastern Ontario may be classified into 3 groups, high Ti magnetite deposits, low Ti magnetite deposits, and hematite deposits. All have been mined in the past. They lie in a deeply eroded terrain mainly in Precambrian rocks, and the

most abundant ore mineral, magnetite, is confined to those rocks. Part of the hematite is found in Paleozoic rocks at or near the contact with the Precambrian complex. The magnetite deposits occur in greater numbers and in larger deposits than the hematite deposits and appear to be potentially more valuable as sources of Fe ore because of their greater size and the ready method of magnetic concentration. This should not discourage search for mineable hematite however, as good grade hematite ore has been mined in the past and may be found in the future. The low Ti magnetite deposits have yielded most ore, and are more favorably regarded because of their low Ti content and relative ease of concentration. Both high and low Ti types include deposits that might be expected to yield more than a million tons of low-grade concentrating ore material.

Geological relationships of the gabbroic host rocks to the ore materials of the high Ti magnetite deposits indicate a close genetic relationship between them. This is supported by the similar distribution of trace elements in the host rocks and ore materials.

Geological relationships between the host rocks and ore materials of the low Ti magnetite deposits do not clearly indicate a close genetic relationship between them. The distribution of the elements in the ore materials of this class is more similar to that in the average gabbro than in the average granite, and it is suggested that these magnetities were derived by differentiation of magma perhaps slightly less mafic than gabbro. The distribution of the ferride elements in magnetic concentrates from high Ti and low Ti magnetite deposits, and in pyrite closely associated with low Ti magnetite deposits, supports this view. It seems reasonable to assume that these magnetite deposits are the result of differentiation and separation from gabbroic rocks, and that the characters are due partly at least, to differences in distance from source and to degree of differentiation at time of emplacement.

Geological relationships between the hematite deposits and their host rocks do not indicate a close genetic relationship, but do suggest that the hematite deposits are, in part at least, derived by alteration of ferruginous minerals originally present in the host rock. Such minerals include pyrite, chalcopyrite, Fe-bearing carbonates, and magnetite or martitized magnetite. The variety martite, pseudomorphous after magnetite, seems to be restricted to the old Precambrian zone of weathering. With the exception of Fe and possibly of Mn, these hematite-rich deposits seems to be slightly more deficient in the ferrides than the magnetite deposits. --Auth. introd. and concl.

1-2897. Mero, John L. A PRELIMINARY REPORT ON THE ECONOMICS OF MINING AND PROCESSING DEEP-SEA MANGANESE NODULES: 96 p., 2 diags., 2 graphs, 23 tables, Berkeley, University of California, Institute of Marine Resources, Jan. 1959, 39 refs.

Although the existence of small, brown-black concretions of manganese dioxide on the floor of large areas of the world's oceans has been known for almost 85 years, only recent dredge hauls from comparatively shallow waters has warranted an engineering study of the technical and economic aspects of mining and processing this material.

Commonly known as Mn nodules, this material occurs in pelagic sediments as microscopic grains of iron oxides and manganese peroxides, at the surface of the pelagic sediments as small (generally 1 to 6 in. in diameter) spherically shaped nodules, and as a surface coating on many underwater outcrops of rock or loose-lying stones. Estimates of the tonnages of Mn nodules available for mining range into the hundreds of billions of tons.

An average grade of this material dredged up from all over the world is 20% Mn, 15% Fe, and 0.5% each of Ni, Co, and Cu. Locally the nodules grade as high as 45% Mn, 1% Co, 1.4% Ni, and 1.8% Cu, not all in the same nodule, however.

The nodules are related to a variety of Mn ores known as wad or bog Mn. Because of the intimate relationship of the various elements in the nodules, there is little chance of upgrading the nodules by any process such as flotation. Preliminary hydrometallurgical experiments indicate that any of the processes developed for winning Mn from low-grade domestic ores should work satisfactorily from a technical standpoint in the recovery of Mn from the nodules. It is relatively simple to dissolve the Ni, Co, and Cu in the nodules once the Mn is made soluble by a reduction process.

Preliminary calculations on the mining of the nodules from the deep-sea floor indicate that such an operation is practical both technically and economically. Two methods are described, deep-sea drag dredging and deep-sea hydraulic dredging. Drag dredging is a semiproven technology currently used in scientific dredging applications. This method generally incurs high mining costs, primarily because of the time that it takes to lower and raise the dredge bucket. Still, the method is economic under favorable circumstances.

The main components of a deep-sea hydraulic dredge have been in use in industry for a number of years. This method of recovering the nodules, if operationally practical, would lead to low ($3. to $5. per ton) mining costs.

Should commercial mining of this material prove feasible, the present state of ocean law would lead to many legal complications. An international ocean mining law is needed before this happens. --Auth.

1-2898. Redden, Jack A. BERYL DEPOSITS OF THE BEECHER NO. 3-BLACK DIAMOND PEGMATITE, CUSTER COUNTY, SOUTH DAKOTA: U.S. Geol. Survey, Bull. 1072-I, p. 537-559, 2 maps (1 in pocket, scale approx. 1 in. to 40 ft., contour interval 10 ft.), secs. (in pocket), diag. (in pocket), 1959, 10 refs.

The Beecher No. 3-Black Diamond pegmatite, near Custer, South Dakota, is one of the most important sources of beryl in the United States. The presence of abundant beryl was discovered in 1952, and 342 tons of beryl concentrates was produced from this deposit between 1952 and 1956.

The pegmatite is exposed in an elongate northward-trending area that is 1,750 ft. long and a maximum of 160 ft. wide. It forms a roughly pipelike mass that plunges gently southward and has on its crest many longitudinal ridges, or rolls, that plunge both northward and southward. The S. end of the pegmatite is formed of 2 coalescing segments believed to have been injected at slightly different times.

The pegmatite can be subdivided into at least 5 zones and is cut by 2 kinds of fracture-filling units. The zones, numbered in order of position inward from the periphery, are constituted as follows: 1) quartz-muscovite-albite pegmatite (border zone), 2) albite-quartz-muscovite pegmatite (wall zone), 3) quartz-albite-muscovite-perthite-beryl pegmatite, 4) perthite-quartz-albite pegmatite, 5) perthite-

quartz pegmatite. The fracture-filling materials are quartz-spodumene pegmatite and quartz pegmatite. An additional spodumene-rich zone was exposed by deeper mining after completion of the detailed investigation.

The pegmatite is believed to have been intruded as a mass of pegmatitic magma, which crystallized inward by progressive fractionation.

The pegmatite contains deposits of spodumene as well as beryl and could also yield a large amount of scrap mica as a byproduct. The main beryl deposit, containing 5 to 10% hand-cobbable beryl, is in zone 3; it occurs only in 1 roll on the crest of the pegmatite and along the contact between the 2 coalescing segments. Large reserves of finer grained beryl occur in the wall zone. The spodumene exposed by deeper mining is believed to occur in a zone that is still largely concealed and thus of unknown dimensions. Additional exploration for both beryl and spodumene is warranted. --Auth.

1-2899. Socolow, Arthur A. GEOLOGY OF A BARITE OCCURRENCE, FULTON COUNTY, PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 33, p. 204-208, 5 figs., 1959, 3 refs.

During the summer of 1957 an attempt at commercial development of a barite occurrence, about 1 mi. N. of Ft. Littleton, along Little Aughwick Creek in Fulton County, resulted in a favorable exposure which has permitted a study of the geologic relationships and paragenesis of the mineral occurrence. Several open pits and trenches exposed the mineralized zone underlying the rolling farmland. --Auth.

1-2900. Sinclair, W.E. ANTHOPHYLLITE ASBESTOS: ITS PLACE IN INDUSTRY: Asbestos, v. 41, no. 4, p. 2-8, Oct. 1959.

Anthophyllite asbestos is a relatively short-fibered variety, most useful in cases where spicule-free fibers are necessary, as in paints, insulating cements, filtration, and many plastics. Because of the relatively low present demand, there are few deposits classed as economically important. Most countries mine only enough to supply their national demand. The world reserves of anthophyllite are estimated at about 1% of the total for all varieties of asbestos minerals. --M. Russell.

1-2901. Govett, G.J.S. INDUSTRIAL MINERALS OF ALBERTA: Can. Mining & Metall. Bull., v. 52, no. 564, p. 261-266, 3 maps, graphs, Apr. 1959, 18 refs.

The reserves of industrial minerals of Canada's western plains are probably several times more valuable than all the known deposits of metallic minerals of the Canadian Shield. The value of Alberta's production of industrial minerals has increased from approximately 2 million dollars in 1926 to over 20 million in 1956. A brief review of the known occurrences of industrial minerals in Alberta is given, covering bentonite, stoneware and refractory clays, brick and tile clay, lightweight aggregates and rock wool, limestone, dolomite, gypsum, silica sand, salt, sodium sulfate, phosphate, S, Br, and Mg in oil-field waters. Except for high-quality clays and gypsum, production of industrial minerals in Alberta is probably adequate for present local requirements. Large untouched resources exist. A more comprehensive review of industrial minerals in Alberta has been listed as GeoScience Abstracts 1-257. --A. C. Sangree.

1-2902. Baird, David M. DEVELOPMENT OF GYPSUM DEPOSITS IN SOUTHERN NEWFOUNDLAND: Can. Mining & Metall. Bull., v. 52, no. 568, p. 495-502, 6 illus., 3 maps, graph, Aug. 1959, 17 refs.; also pub. as: Can. Inst. Mining and Metallurgy, Trans., v. 62, p. 257-264, 1959.

Enormous deposits of gypsum of exceptionally high grade are readily accessible in southwestern Newfoundland. Coming large-scale production from one of these is resulting in renewed interest in deposits which have been known for more than 120 years.

General stratigraphy and structure of the Carboniferous rocks in which the gypsum occurs are described. The stratigraphic position of the basal gypsum-anhydrite zone is described. This massive evaporite horizon, which reaches a thickness of about 1,000 ft., appears at Fishels-Heatherton, where it is largely undeveloped, and again on the nose of an anticline E. of Flat Bay, where a present production of 20,000 to 40,000 tons per annum is soon to be expanded to make it one of Canada's major producers. Detailed descriptions are given of the several types of gypsum, the relation of the gypsum and anhydrite, and the distribution of sodium chloride in the evaporite beds. The bearing of all these on the origin of the gypsum is discussed. Brief reference is made to relation to world markets, mining and transportation, grade, and reserves. --Auth.

1-2903. Eckhart, Richard A., and George Plafker. HAYDITE RAW MATERIAL IN THE KINGS RIVER, SUTTON AND LAWING AREAS, ALASKA: U.S. Geol. Survey, Bull. 1039-C, p. 33-65, 4 illus., 5 maps (2 in pocket), graph, 6 tables, 1959, 13 refs.

Argillaceous rocks and associated graywacke of the Matanuska formation, of Late Cretaceous age, are exposed in much of the Matanuska Valley. At the confluence of the Matanuska and Kings rivers, and on the Matanuska River about 3 mi. E. of Sutton, there are deposits of argillaceous shale of the Matanuska formation that are possible sources of raw material for haydite. Clays and shales that are suitable raw material for haydite must bloat when heated, produce a glassy phase viscous enough to trap a gas, and contain a material that will evolve a gas at or slightly above the temperature at which the glassy phase is produced. Bloating tests of the argillaceous material from the Kings River and Sutton areas indicate that the shale meets these qualifications and is a good source of raw material for haydite. Large reserves are available, and both localities are close to transportation, fuel, and a market.

N. of Lawing, along the Alaska Railroad and the Seward-Anchorage highway, interfingering argillite, slate, and graywacke of probable Mesozoic age crop out. Bloating tests of the argillite indicate that it is a suitable source for haydite raw material. --Auth.

1-2904. Stewart, Glenn W. LIGHTWEIGHT AGGREGATE RAW MATERIALS IN NEW HAMPSHIRE: New Hampshire State Plan. & Devel. Comm., Mineral Resources Survey, Pt. XVII, 30 p., map, 2 tables, 1959, 26 refs.

The report briefly presents information on obtaining and testing rock samples secured from low grade metamorphic zones, and confirms earlier test data on New Hampshire clays. The heat bloating of one

rock sample produced an aggregate weighing 33.03 lbs. per cu. ft. Concrete test blocks made with this aggregate possessed compressional strengths ranging from 2,050 to 2,850 lbs. per sq. in. Detailed recommendations for a more comprehensive study are presented. --T. R. Meyers.

1-2905. Leighton, Henry. CLAY AND SHALE RESOURCES IN PENNSYLVANIA: Pennsylvania Geol. Survey, Bull. M 23, 245 p., pl., fig., 1941, second printing 1959, 171 refs.

Clay and shale and the products made from them constitute one of the most important mineral resources of the state. Every county has workable clays or shales within its boundaries, and there are few counties that have not at some time produced some ceramic products. Glacial clays are abundant in the northeastern and northwestern counties; bedded shales are found in nearly every county; fire clays of high quality accompany the bituminous coals in the western counties; alluvial clays are present on the flood plains and terraces along the main rivers; and residual white or colored clays are to be found in many areas in the central and eastern parts of the state. --Auth.

1-2906. Quebec (Province), Dept. of Mines. DESCRIPTION OF MINING PROPERTIES EXAMINED IN 1956 AND 1957 (EXCLUSIVE OF PRODUCING MINES); AN OUTLINE OF GEOLOGY AND EXPLORATION WORK: Its: Prelim. Rept. no. 390, 97 p., 9 maps, 1959, refs.

The mining properties described here were examined in 1956 and 1957. Examinations of properties in the Chibougamau region have been described in Prelim. Rept. 352 and 388 (GeoScience Abstracts 1-1549) and are not covered in this report. Names of companies and descriptions of their holdings were correct at the date of examination. The descriptions are of properties that have not reached the production stage; information concerning producing mines appears annually in The Mining Industry of the Province of Quebec. Properties are listed alphabetically by township. Geology is briefly described in each case; also development work and assay results when available. References to published information on the described properties are given at the beginning of each description. Township maps at the end of the report show boundaries of the various properties. An alphabetical index to names of companies or property owners is provided. --A. C. Sangree.

13. FUELS

See also: Areal and Regional Geology 1-2695, 1-2701, 1-2703, 1-2704, 1-2707, 1-2708, 1-2709; Stratigraphy 1-2745, 1-2756; Geochemistry 1-2826; Miscellaneous 1-2931.

1-2907. Cadle, Austin. UNITED STATES PETROLEUM FORECAST AND DYNAMIC WORLD GROWTH IN PETROLEUM DEMANDS: Am. Petroleum Inst., Proc., Sec. 6 (Interdivisional), v. 38, p. 24-30, 4 figs. incl. map, graphs, 1958.

After the plateau of 1957 and 1958, the petroleum industry will continue its dynamic growth rate through 1975. In 1959 petroleum demand will increase 4% in the United States and 11% in the free foreign areas.

The demand for petroleum products is closely associated with people, their productivity, and the extent of industrialization. In the period to 1975 the population of the total free world will increase by approximately 30%, but total energy requirements will almost double, and petroleum demand will increase 134%. In the United States during this period, population will increase by 33%, while total energy requirements increase 83% and petroleum demand increases 76%.

As a result of these increases in demand, changes will occur in relative yield of each product from the barrel of crude oil. In the United States, gasoline and jet demand are expected to double by 1975, and thus increase to more than 50% of the barrel of crude oil, while in Western Europe, by contrast, fuel oil will show the strongest growth, nearly quadrupling by 1975, increasing to more than 40% of the barrel of crude oil.

These increases in petroleum use will, of course, require great expansion of refining, transporting, and marketing facilities. Thus, the free world tanker fleet must nearly triple, while refining capacity will expand by some 136% to a total of 42 million barrels. More than half of the capacity increase will be outside of the United States.

With this outlook, petroleum will continue to be one of the outstanding growth industries in the United States and the free foreign world. --Auth.

1-2908. Sakakura, A. Y., Carolyn Lindberg, and Henry Faul. EQUATION OF CONTINUITY IN GEOLOGY WITH APPLICATIONS TO THE TRANSPORT OF RADIOACTIVE GAS: U.S. Geol Survey, Bull. 1052-I, p. 287-305, 6 graphs, 2 tables, 1959, 3 refs.

The transport of matter by fluids percolating through a porous medium is described by setting up a mass-conservation equation, analogous to that of hydrodynamics, for each of the substances in question. The sources and sinks of these equations serve to take into account the contribution from the medium and the interactions with other transported substances. The transport of Rn by natural gases is treated in detail for the case of 2 important sources: the extended source and the cylindrical-shell source. From the solutions of the steady-state cases, the 2 source types can be distinguished, provided source density is uniform. From the solution of the transient case, the boundary of the source nearest to the gas well can be established. The results are applied to some selected data from the Texas Panhandle gas field. --Auth.

1-2909. Hodgson, Gordon W., and Brian Hitchon. PRIMARY DEGRADATION OF CHLOROPHYLL UNDER SIMULATED PETROLEUM SOURCE ROCK SEDIMENTATION CONDITIONS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 10, p. 2481-2492, chart, diag., 3 graphs, 4 tables, Oct. 1959, 22 refs.; also pub. as: Research Council Alberta, Contr. Ser. no. 94.

Experiments were carried out to determine the extent of preservation and the extent of conversion to pheophytin, of chlorphyll dissolved in oil, during sedimentation with illite, montmorillonite, and kaolinite in fresh and salt water and under varying conditions of pH and redox potential.

The major controlling factor in these systems was pH, and it was found that at high pH values chlorophyll was extensively destroyed, and as acid conditions were approached the preservation of total pig-

ment was good with increasing conversion to pheophytin. Both the conditions of pH and redox potential favorable for the formation of petroleum and the preservation and conversion of chlorphyll were found to be coincident. --Auth.

1-2910. Beard, Dena E. SELECTIVE SOLUTION IN THE DEVONIAN SWAN HILLS MEMBER: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 7, illus., July 1959, ref.

Selective removal of aragonite but not of calcite created an effective porosity in the Swan Hills oil field, Alberta, [150 mi. NW. of Edmonton]. --Auth.

1-2911. Ellison, A.H. EVIDENCE OF SUPERSATURATED ZONES IN THE ATHABASCA OIL SANDS: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 8, p. 177-178, illus., Aug. 1959, 2 refs.

The term "supersaturated" occasionally applied to the Lower Cretaceous McMurray oil sands appears to be justified. Several core holes and one outcrop exposure reveal lenses of thick oil containing only minute amounts of sand. These bodies are considered to have accumulated slowly in small tension fissures set up over Devonian microtopography. --Auth.

1-2912. Herbaly, E.L. GEOMETRY OF OIL AND GAS ACCUMULATIONS ASSOCIATED WITH THE EDMONTON REEF CHAIN IN CENTRAL ALBERTA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 7, p. 141-148, 10 maps, chart, July 1959.

The oil and gas fields along the Edmonton reef chain show the following complex stratigraphic relationships which control the entrapment of hydrocarbons: 1) Devonian reefs, 2) structural closure in sediments above the reefs, 3) variations in porosity, 4) truncated edges of Mississippian units, 5) lenticular Cretaceous sands. --Auth.

1-2913. Hunt, C. Warren. DEVELOPMENTS AT PANTHER RIVER, 1956 TO 1959: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 7, p. 157-160, profile, chart, July 1959, ref.

Three wells drilled since publication of the original report on the geology of the Panther dome [Alberta, Canada]: 1) reveal the high S character of the gas; 2) strengthen the concept of the antiquity of the dome; and 3) supply information on the low angle and folding of the McConnell fault in the vicinity. --Auth.

1-2914. Renaud, Jacques E. PROVOST GAS FIELD, ALBERTA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 6, p. 131-136, 5 maps, 3 secs., June 1959.

The Provost gas field is located in E.-central Alberta about 172 mi. NE. of Calgary. It is a typical Upper Cretaceous gas field and one of the most important shallow (2,690 ft.) gas accumulations in Alberta.

Gas production is from the Viking formation. There are now 63 gas wells in the field, and ultimately about 394 gas wells will be on production. The proven, probable, and possible gas reserves are 926 billion cu. ft. The field covers an area of 333,853 acres. The average reservoir pressure is 850 p.s.i. The gas is committed for sale to the Trans-Canada Pipe Line system, and at present 33 million cu. ft. per day are being delivered. The accumulation of gas in the Provost field is due to updip pinch out of the Viking sand, in turn overlain by Colorado shales. Other gas fields of similar type are present in E.-central Alberta, and planned wildcat drilling will probably uncover similar accumulations. --Auth.

1-2915. Cordon, B.B. EXPLORATION ACTIVITIES AND PROBLEMS OF SOUTHWESTERN ONTARIO: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 4, p. 69-81, 2 maps, 5 secs., Apr. 1959, 14 refs.

Oil and gas exploration in southwestern Ontario dates from the 19th century, with more than 10,000 borings having been drilled to the present time. Production is obtained from the lower Paleozoic rocks of Devonian, Silurian, and Ordovician age and, with the exception of basal Silurian gas production in the Fort Erie area, is from carbonate reservoirs. Practically all drilling is done with cable-tool rigs.

During 1957 a total of 627,000 barrels of high gravity oil and 14.4 billion cu. ft. of natural gas were produced in the area. Currently 3,500,000 acres of registry freehold lands are held under lease, and 1,568,000 lake acres are operated under provincial leases or permits. Unique lake drilling and reef reservoir gas storage operations are being undertaken on an ever increasing scale.

A total Paleozoic sedimentary column of 4,700 ft. is known from borings and exploration that have been directed, not only to presently producing Devonian and Silurian horizons, but to the Ordovician Trenton formation and Precambrian mantling basal sands. Approximately 75% of the provincial oil production is obtained from the Devonian Dundee formation. Gas production is largely from the Silurian lower Salina and Guelph formations. A variety of reservoir traps have been encountered, although stratigraphic traps of biostromal and biohermal origin are of major importance.

A total of 31 biohermal pinnacles have been found around the eastern and southern shores of Lake Huron. Sedimentary thin zones and pinchouts occur in the vicinity of reef structures, and anomalous absences of salt over reefs are encountered. Extensive salt leaching is suggested as the explanation for such supra-reef salt absences with removal having been accomplished during Silurian upper Salina and Middle Devonian times. --Auth.

1-2916. Goebel, E.D., Paul L. Hilpman, and D.L. Beene. OIL AND GAS DEVELOPMENTS IN KANSAS DURING 1958: Kansas, State Geol. Survey, Bull. 138, 228 p., 9 maps (3 in pocket), 5 graphs, 33 tables (1 in pocket), Sept. 1959, 40 refs.

Kansas oil production in 1958 totaled 119,094 barrels, a decline of 3.3% from the previous year. The 1958 output of crude oil decreased in value to $362,225,124 from $380,845,912 in the preceding year, because of decreased price and production.

Natural gas production in Kansas totaled 535.9 billion cu. ft. (14.65 p.s.i.a.); the Hugoton gas area produced 349.3 billion cu. ft., about 65% of the total.

During the year, 136 new oil fields, 16 new gas fields, and 5 that were both oil and gas field were discovered; 8 previously abandoned oil fields and 2 gas fields were revived.

In 1958, a total of 4,190 wells was recorded as drilled in Kansas counties in connection with the petroleum industry. Of the recorded completions, 1,846 were oil wells, 227 were gas wells, 58 were

both oil and gas, 1,884 were dry holes, and 175 were salt-water disposal wells or wells used as input wells in secondary recovery operations. Of the 1,884 dry holes, 417 were wildcats. Estimates of wells not specifically reported, but for which drilling permits were issued, bring the total number of wells drilled in the state during the year to 5,569.

As in 1957, Barton County, which produced 11,546,500 barrels, was the leading oil producing county. Ellis and Russell counties, ranked second and third, produced 11,314,968 barrels and 9,005,985 barrels respectively. The Bemis-Shutts field of Ellis and Rooks counties was the top-ranking field in the state. The 6 leading oil fields - Bemis-Shutts, El Dorado, Trapp, Hall-Gurney, Chase-Silica, and Kraft-Prusa - accounted for about 19% of the total annual production.

In 1958, Kansas fields produced 225.2 million gallons of natural gas liquids, valued at more than 10.2 million dollars. Proved reserves of natural gas liquids are nearly 200 million barrels. The proved reserves of Kansas crude oil at the end of the year were 922.4 million barrels, or 2.6% less than the previous year's reserves. Proved reserves of natural gas are more than 20.2 trillion cu. ft.

Production from recorded secondary recovery projects in Kansas amounted to 11,580,189 barrels of oil during 1958, but allowance for projects not specifically reporting boosts the total to an estimated 17.1 million barrels. Recorded totals of 5,497 oil wells and 3,586 injection wells were active during the year. Greenwood County, which yielded 5,241,040 barrels, led in the amount of oil produced by secondary recovery methods. --Auth.

1-2917. Schneider, Stephen J. BAY SAINTE ELAINE OIL FIELD, SOUTHERN LOUISIANA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 10, p. 2470-2480, 7 maps, 6 secs., table, Oct. 1959, 6 refs.; also pub. as: Washington Univ., St. Louis, Missouri, Dept. Geology, Pub. no. 178.

The interpreted and geologic history of the Bay Sainte Elaine field, southern Terrebonne Parish, are the result of a detailed analysis and correlation of electric logs and the use of scout cards. The structure is that of a piercement-type salt dome exhibiting radial faulting on all but the NW., SE., and E. flanks of the structure. Evidence of major faulting, and depositional characteristics during the interval between the BA and BB_1 times (upper Miocene), seem to indicate that it was the period of maximum salt growth. Major hydrocarbon accumulation probably took place in late Miocene or early Pliocene time. --Auth.

1-2918. Picard, M. Dane. WHITE MESA FIELD, ENVIRONMENTAL TRAP, SAN JUAN COUNTY, UTAH: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 10, p. 2456-2469, 4 maps, 3 secs., Oct. 1959, 14 refs.

Located on the southern flank of the Paradox basin, the White Mesa field (with one exception) produces from the Desert Creek zone of Pennsylvanian (Cherokee) age. To Dec. 1, 1958, there were 48 oil wells.

Structurally the area can be divided into 2 units. The southeastern part strikes N. 30°W. -N. 90°E., and dips gently W. and N. at approximately 60-115 ft. per mi. It is probable that this part is the W. and N. flanks of an anticline located E. and SE. of present wells. In the northwestern part of the field, a small area of "closure" is present. This part trends NW. -SE., and is related to the Ratherford field NW. of White Mesa. It is separated from the southeastern part of White Mesa by a narrow syncline opening(?) NE.

Stratigraphically the field is an area of rapid lateral and vertical lithologic change. Broadly it can be divided into 3 units: high-carbonate (more than 79%) rocks on the northern margin; high-carbonate rocks trending N. -S., subsidiary to the northern unit; and a restricted lithofacies bordering the northern margin and surrounding the N. -trending carbonate lithofacies. Because of these variations oil has been environmentally trapped. The specific change, most instrumental in entrapment, is the transition from deposits of a shallow, well oxygenated, agitated, marine environment to deposits of a deeper-water, relatively quiet, restricted, marine environment. The latter might be called "lagoonal."

Many wells in White Mesa produce from rocks deposited in the restricted environment; 11 dry holes have found a slightly greater environmental restriction and were not productive due to negligible permeability.

In origin, White Mesa and the related fields (Aneth, McElmo Creek, Ratherford) have been called a "reef complex." The writer believes the term biostromal complex to be more descriptive of Desert Creek zone stratigraphy in the area. --Auth.

1-2919. Schoewe, Walter H. COAL RESOURCES OF THE CHEROKEE GROUP IN EASTERN KANSAS. I. MULKY COAL: Kansas, State Geol. Survey, Bull. 134, pt. 5, p. 181-222, 10 illus., 4 maps (1 in pocket, scale approx. 1 in. to 2 mi.), 3 secs., 7 tables, June 1959, 60 refs.

The Mulky coal is the uppermost coal in the Cherokee group of rocks (Pennsylvanian). It occurs in Bourbon and Crawford counties, Kansas, where it has been mined, either by stripping or by drifting into the hillsides, only along the edge of the Fort Scott limestone escarpment. Where mined, the Mulky coal is 7 to 22 in. thick, but averages only 12 in. Mulky coal is classified as bituminous coal of high volatile A to B rank. Ash content is 10 to 25%, volatile matter 30 to 36%, moisture less than 2%, S 3 to 6%, and heating value (moisture free basis) 10,000 to 13,000 B. t. u. Of the 3,582,630 tons of Mulky coal estimated and computed to have been mined, Bourbon County produced 2,415,360 tons and Crawford County 1,167,270 tons. Measured coal reserves 12 to 22 in. thick are estimated to underlie an area of 21,159 acres, all but 366 acres of which is in Bourbon County, and to total 47,020,450 tons. Indicated reserves underlie 53,679 acres, all in Bourbon County, and total 126,416,550 tons. Recoverable measured Mulky coal is estimated at 35,265,388 tons. --Auth.

14. ENGINEERING GEOLOGY

See also: Geologic Maps 1-2668; Areal and Regional Geology 1-2692; Geophysics 1-2817; Geohydrology 1-2880.

1-2920. Glazov, N.V., and A.N. Glazov. NEW INSTRUMENTS AND METHODS OF ENGINEERING GEOLOGY. Tranlated from Russian, by J. Paul Fitzsimmons: 91 p., 17 figs., New York, Consultants Bureau; London, Chapman & Hall, 1959, 43 refs.

English translation of Novye Pribory i Metody, Primenyaemye v Inzhenerno-Geologicheskikh Izyskaniyakh.

Most of the instruments and methods are concerned with soil engineering rather than engineering geology, with emphasis on determination of moisture content and soil density by radioactive materials, and on equipment for measuring shearing resistance and porosity. Methods are described for the study of deflation utilizing a sand trap, fluorescent dyes, and radioactive elements. In geohydrology, a modification of the Ranney method of water intake is discussed. Evaluation of borehole data using radioactive drilling muds and radioactive isotopes is covered, and a brief treatment is given to vibrodrilling. Many essential details for design of the instruments are omitted, but the authors point out the limitations and advantages of each technique and method. The appendices include a table of radioactive isotopes, and rules for working with radioactive materials. Literature cited in the bibliography is mainly in Russian. --A. H. Nicol.

1-2921. Corlett, A.V., and C.L. Emery. PRESTRESS AND STRESS REDISTRIBUTION IN ROCKS AROUND A MINE OPENING: Can. Mining & Metall. Bull., v. 52, no. 566, p. 372-384, 17 figs. incl. illus., diags., graphs, table, June 1959, 27 refs.; also pub. as: Can. Inst. Mining & Metallurgy, Trans., v. 62, p. 186-198, 1959.

The stress equilibrium is disturbed in a body of rock by a mine opening and is restored by a redistribution of the stresses around the opening. The pattern of the redistribution of unilateral stress around an opening has been established by mathematical analysis and photoelastic measurements. The pattern for multilateral stress is found by superimposition of unilateral fields. The mathematical analysts do not use the elastic moduli as parameters, and they are not significant in photoelastic work. The medium is isotropic.

The concept of unilateral stress from vertical loading and the classical pattern of its stress distribution around openings does not explain commonly observed failures around the perimeters of mine openings. They show evidence of compression where tension is postulated.

When it is recognized that few minerals and perhaps no rocks are Hooke Solids, most rocks must be St. Venant Solids. The components have varying degrees of elasticity and viscosity. The assembly will behave elastically to rupture under shock loading, but when loaded short of rupture will adjust viscously to equilibrium. Similarly, the highly elastic components may initiate rupture before equilibrium can be established when stress is instantaneously relieved. Polycrystalline adjustments may produce permanent deformation.

The mechanics of consolidation, especially in sedimentary deposits, acquire a stress component normal to the direction of compaction which can exceed that of the loading. It is one source of prestress. There are others.

The principles of prestress design are based on the normal beam reactions, modified by a built-in compression in the lower chord. When the beam is loaded to design limits, the lower chord retains some compression, and the whole beam depth is effective in compression. Some of the common evidences of failure in compression over a mine opening can be duplicated in a prestressed experimental model. When the triaxial stress pattern is recognized and suitable measuring techniques are devised, mine design can be done on a rational basis. --Auth.

1-2922. Jumikis, Alfreds R. ENGINEERING ASPECTS OF GLACIAL SOILS OF THE NEWARK METROPOLITAN AREA OF NEW JERSEY: Rutgers Univ., Eng. Research Bull. no. 42, 72 p., 41 figs. incl. illus., maps, secs., graphs, 6 tables, 1959, 21 refs.

A report is given on the major soil types encountered and mapped in Bergen, Essex, Hudson, Passaic, Union, and part of Morris counties. In order to illustrate the association of the various soil types with their respective land forms, a short description of the bedrock and glacial geology of the area is included. The Wisconsin glacial drift is described in some detail as the most important source of soil as construction material for earthworks, foundation material, and aggregate for concrete.

The Engineering Soil Survey, lately finished by Rutgers for the state of New Jersey, and the methods and procedures applied in the preparation of engineering soil maps are described, as well as some characteristics of the glacial soil properties of the area. Applications of the engineering soil maps to various engineering problems are indicated, and it is pointed out that the Engineering Soil Survey of New Jersey is a contribution to soil engineering and highway technology. --From auth. introd.

1-2923. Rausch, Donald O. STUDIES OF ICE EXCAVATION: Colorado School Mines, Quart., v. 54, no. 2, 90 p., 57 figs. (5 fold.) incl. illus., map, diags, profiles, graphs, table, Apr. 1959, 34 refs.

Field experiments in the feasibility of tunneling in ice were undertaken at Camp Tuto, Thule area, NW. Greenland. The project undertook the study of 1) glacier features, in particular the origin of ice cliffs; 2) the feasibility of excavating rooms and tunnels under the ice; 3) the feasibility of using coal mining equipment in the tunneling of ice; 4) the feasibility of using explosives in ice tunneling; and 5) the behavior of openings in ice.

Ice cliffs were formed as follows: The flow of ice at the terminus of the cap was blocked by the thinning of the ice by ablation and by additional blocking resulting from the deposition of moraine. With blocking the terminus of the ice cap became immobile so that ice that followed was forced to override the preceding immobile ice and caused the ice carrying rock debris, located at the base of the ice cap, to rise and be exposed at the surface. Then this overriding ice also became immobile, and the ice that followed overrode this newly formed immobile ice. This process repeated itself in the steepening of the ice surface near the terminus of the ice cap. The debris exposed at the surface was freed from the ice by ablation and formed a well-developed terminal moraine on the surface of this steepening. Apparently at a later time snow accumulated on this moraine in a large drift. The side of the drift facing the Tuto ramp, became exceedingly steep and is referred to as an ice cliff. The snowdrift later developed into firm continuous solid

ice superimposed on the terminal moraine and the glacier ice. The glacier ice that was subjected to overthrusting has elongated bubbles, with their long axes oriented in the direction of movement. The optic c-axis shows preferred orientation in the glacier ice, with the c-axis nearly perpendicular to the planes along which movement of the ice took place.

"Manual methods of excavation may be used for small openings to depths of about 150 ft. of ice without too much difficulty. The ice excavated by this method should be free of rock debris and preferably consist of ice similar to that of the superimposed ice. Openings may be driven in ice containing layers of rock debris by blasting the ice with low-velocity explosives. Blast holes may be made by steam when, because of rock debris, the drilling of holes becomes too difficult for a conventional auger drill. Small, portable diamond drills could be used to drill the blast holes in ice containing rock debris, but this method would be expensive. The most practical drill round for tunnel driving was found to be a round with a one-hole cut. Small openings, such as tunnels, can be made successfully by using blasting methods, but for larger openings difficulty is encountered because the blasting damages the roof, and later causes failure. The excavation of under-the-ice openings can be easily accomplished by using many of the same methods of excavating that are used in mining coal - the only limitation being that the ice must be free of rock debris, because it is impossible to cut ice containing debris with coal cutters or continuous miners. The freezing and accumulation of ice dust caused some moving parts on the mechanical mining equipment to stop, or the friction drives to slip. However, this freezing problem could be easily eliminated with properly placed electrical heating arrangements."

The rate of closure of an opening was found to be primarily dependent on the size of the opening, the depth of the opening, and the glacial movement of the ice in which the opening is located. Closure of openings can be prevented by pressurizing with compressed air so that the air in the openings would support the ice. Openings in the ice could be used for storage, fuel dumps, guided missile launching bases, artificial ramps to the ice cap, access through crevassed areas, and even for entire military bases. Another possible use would be the stockpiling of the country's food surplus. --M. Russell, from auth. concl.

1-2924. Fisk, Harold N., and Bramlette McClelland. GEOLOGY OF CONTINENTAL SHELF OFF LOUISIANA: ITS INFLUENCE ON OFFSHORE FOUNDATION DESIGN: Geol. Soc. America, Bull., v. 70, no. 10, p. 1369-1394, 11 illus., 3 maps, 4 charts, 4 profiles, sec., diags., 2 graphs, Oct. 1959, 15 refs.

Foundation problems for drilling structures offshore from Louisiana are related to the shearing strength and scour resistance of near-surface late Quaternary continental-shelf deposits. Over much of the shelf area, thick topstratum clays provide the foundation materials; where clays are thin, underlying substratum sands or weathered late Pleistocene deposits constitute the foundation. Study of the nature of the late Quaternary facies and of their relation to shelf topography makes it possible to map the sediment types and to date them. Compression tests on clay samples permit recognition of 4 categories of strength variation with depth: normally consolidated, underconsolidated approaching normal, underconsolidated, and overconsolidated clays. These tests also demonstrate that substantial time is required for clays to reach a normally consolidated condition. --Auth.

1-2925. Mamrelli, Emil S. DISTRIBUTION PROBLEMS IN AREAS OF UNSTABLE GROUND: Am. Water Works Assoc., Jour., v. 51, no. 3, p. 379-387, 12 illus., map, sec., March 1959.

Los Angeles is faced with the problem of over 100 unstable-ground areas within a 30-mi. radius of the city hall. Earth movement from slides or subsidence has already caused serious damage, and these areas must be stabilized if further damage is to be prevented.

The subsidence is the result of oil and gas extraction which has relieved pressure and caused the overlying strata to be depressed. Subsidence in the Long Beach area has presented some serious problems with water mains, gas pipes, sewers, railroad tracks, and sidewalk and street grades. Engineers and geologists have suggested that water pumped under pressure into the underground basins as the oil and gas are pumped out will retard subsidence and perhaps stop it.

More than 100 slide areas exist in the metropolitan area. Many of these areas are old geologic formations which have been unstable for many years. In some cases, this condition is the result of excavations and fills for roadways, building sites, or other improvements. Some of the slide areas have been especially active in the past 2 years. Although most slide movements are very slow, a few extremely rapid slides have occurred. Underground pipes in these areas have undergone considerable strain. Special materials and methods of installation have been necessary in order to maintain service. Studies now being made of the slides may determine ways to stabilize these areas. --L. M. Dane.

15. MISCELLANEOUS

1-2926. Cramer, Howard Ross. THE GEOLOGIC LITERATURE OF PENNSYLVANIA: Pennsylvania Acad. Sci., Proc. v. 33, p. 209-213, 1959.

The geological literature dealing with Pennsylvania is varied and extensive. It varies from basic new concepts to attacks upon other articles and authors. It includes ancient articles which now are of only historic value and extremely vital papers which are fundamental to geology today. The background of literature which is available for study and consultation is immense, and this article is designed to call attention to it. --Auth.

1-2927. Geijer, Per. GEOLOGY IN SWEDEN: Geo-Times, v. 4, no. 3, p. 8-9, 42, 3 illus., Oct. 1959.

Cambrian oil shale is being studied for potential economic use and as a possible means of positive age dating. The leading geological society in Sweden is "Geologiska Föreningen i Stockholm" with 400 members. The departments of geology at the various educational institutions are described. Iron-ore development is important; during World War II much emphasis was placed on developing deposits of minerals which were denied Sweden. Engineering geology has played a large part in extensive development

of underground installations. --M. Russell.

1-2928. Whitmore, George D., Morris M. Thompson, Julius L. Speert. MODERN INSTRUMENTS FOR SURVEYING AND MAPPING: Science, v. 130, no. 3382, p. 1059-1066, 11 illus., Oct. 23, 1959, 23 refs.

Modern surveying and mapping practice is to a large degree dependent on use of the aerial photograph and application of the science of photogrammetry. The stereomat achieves automatic stereoscopic perception. This may make possible the preparation automatically, by coupling with the orthophotoscope, of aerial photographs which are completely free of distortion due to ground relief; they can thus be used as maps with true scale. The tellurometer permits the rapid measurement of precise distances up to 40 mi. under adverse conditions of terrain, climate, and light. Radar altimetry, radar photography, and carborne vertical control are useful developments for reconnaisance mapping. --M. Russell.

1-2929. Gary, George L., and Robert A. Matthews. MINERAL EXHIBIT: California Div. Mines, Mineral Inf. Service, v. 12, no. 9, p. 1-11, 8 illus., chart, Sept. 1959, 3 refs.

This paper presents a handy reference to the Division of Mines mineral exhibit. The history of the exhibits, from their conception in 1880 to their present location in the Ferry Building, provides interesting background information for visitors. The main function of the mineral exhibit is to emphasize the various aspects of the mineral industry and the science of mineralogy.

More than 20,000 specimens are on display or available for display. The exhibits include a collection of minerals based on the Dana system of classification; county exhibits which include most of the metallic and nonmetallic ores produced by each California county; mineral commodities of California, as well as many other parts of the world; special exhibits which include: Crestmore collection, meteorites, fossils, relief maps, models, California U, Au, building stones, petrographic study collection, fluorescent materials, gem stones, and an illustrative rock exhibit.

Particularly useful is a map of the exhibit rooms showing the location of the various displays. The minerals, arranged according to the Dana system, that are in the Division of Mines collection are listed in alphabetical order to aid visitors in locating specific specimens. --Auth.

1-2930. Richards, Horace G. GEOLOGY FROM 1812 IN THE MUSEUM: Frontiers, v. 24, no. 1, p. 22-23, Oct. 1959.

The Academy of Natural Sciences of Philadelphia is the oldest continuously operating natural history museum in the United States. Founders were: Thomas Say, Gerard Troost, Camillus Macmahon Mann, Jacob Gilliams, John Shinn, Jr., Nicholas Parmentier, and John Speakman. A hall for the Academy was built in 1815, and in 1817 the first issue of a scientific periodical, The Journal, was published, largely due to the interest of William Maclure, one of the best-known geologists of the day. Academy members participated in various government expeditions to the West between 1819 and 1843. Men who contributed to the geological and paleontological activities of the Academy during the 19th century included: Samuel Morton, Timothy Conrad, Isaac Lea, Thomas B. Wilson, Joseph Leidy, William S. Vaux, William M. Gabb, E. D. Cope, George Tryon, and Henry A. Pilsbry. The first dinosaur skeleton found in America, in Haddonfield, New Jersey, was presented to the Academy in 1858. In 1876 the Academy moved to its present location, and in 1877 a Mineralogical Section was established and expanded in 1879 to the Mineralogical and Geological Section. In 1936 the Dept. of Geology and Paleontology was reactivated. Recent geological activities include the organization in 1948 of a project for study of geology and paleontology of the Atlantic Coastal Plain. --A. C. Sangree.

1-2931. Lytle, William S. CYRUS D. ANGELL: GeoTimes, v. 4, no. 3, p. 18-19, 45, port., map, Oct. 1959.

Cyrus D. Angell became involved in the oil business in 1867. He was the first to develop evidence that oil existed in 2 "belts," map probable areas of oil occurrence based on such evidence, and thereby successfully bring in new wells. --M. Russell.

1-2932. Gillson, Joseph L. GEOLOGICAL EMPLOYMENT - PRESENT AND FUTURE: GeoTimes, v. 4, no. 3, p. 10-11, 40, Oct. 1959.

This article is the second in GeoTimes on the subject of geological employment. The first was listed as GeoScience Abstracts 1-2402.

A detrimental effect of intense recruiting of geologists during periods of expansion is the inclusion as "geologists" of many who are actually subprofessional, resulting in a downgrading of the profession as a whole. In spite of current slack the long-term employment outlook is good, for the country appears to be entering a period of intense technological expansion requiring larger and new supplies of raw materials. Students should go into geology because they like the work, not because they think they can make money in it. The necessity for postgraduate work to succeed in geology becomes greater all the time. --M. Russell.

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